HEATING AND VENTILATING

INCLUDING AIR CONDITIONING — PIPING — EQUIPMENT

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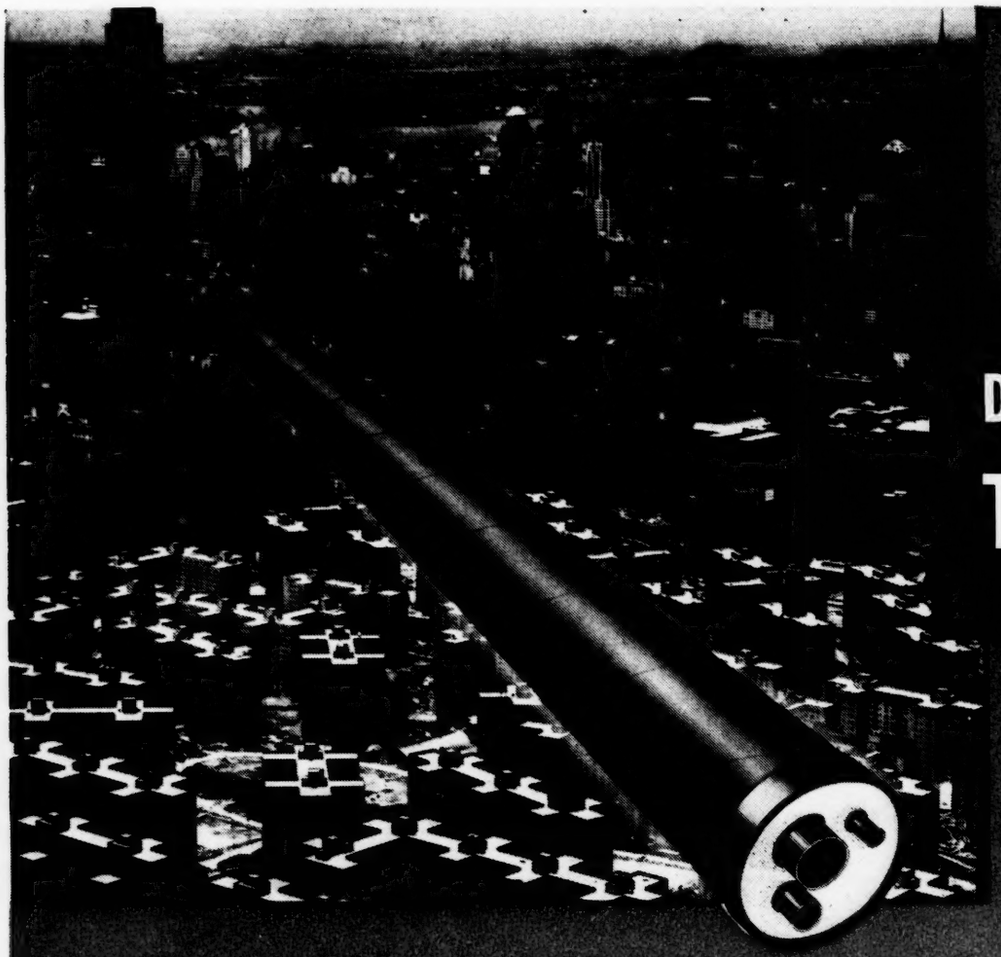

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THE RIC-WIL COMPANY · CLEVELAND, O.

OVERHEAD — UNDERGROUND

FOR FORTY YEARS THE GREATEST NAME IN INSULATED PIPING SYSTEMS

HEATING AND VENTILATING

A MONTHLY MAGAZINE FOR ENGINEERS AND CONTRACTORS CONCERNED WITH THE DESIGN AND APPLICATION OF AIR CONDITIONING, REFRIGERATION, PIPING, AIR SANITATION, HEATING AND VENTILATION IN BUILDINGS

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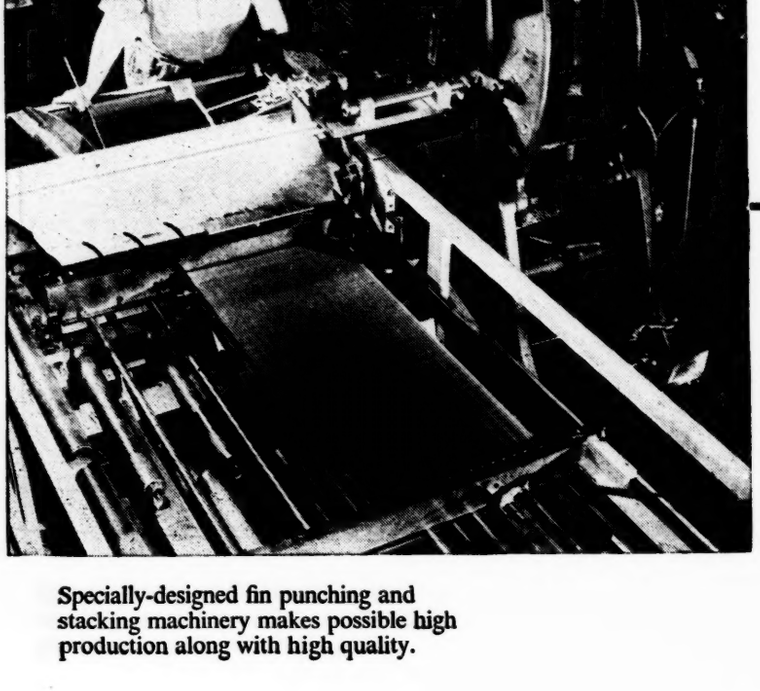
PUBLISHERS OF MACHINERY & MACHINERY'S HANDBOOK
The INDUSTRIAL PRESS

THIS MONTH'S COVER

Maintaining comfortable summer temperatures inside theaters is important for business reasons. Medium and small theaters often rely on straight ventilation to obtain comfort for the patrons. For details of such systems, see article on page 57. Photograph by Philip Gendreau.

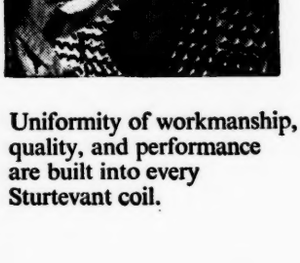
In cooling or heating coils



Specially-designed fin punching and stacking machinery makes possible high production along with high quality.

Sturtevant

GIVES YOU PROVEN PERFORMANCE



Uniformity of workmanship, quality, and performance are built into every Sturtevant coil.

Proper expansion of tubes provides best heat distribution to finned surfaces.

Washington News

LORING F. OVERMAN

"KEYNOTE of the defense program is expansion of facilities."

The sharing of scarcities between the civilian population and the military will be only an initial phase of the defense program, it is becoming apparent as Government planners go into action. Instead, the program calls for expansion of facilities to a point permitting production totals undreamed-of in the past.

Latest to echo this thought—voiced time and again in recent weeks by Government spokesmen—is Leon Keyserling, chairman of the President's Council of Economic Advisers. Speaking October 23 in New York City, Mr. Keyserling forecast growing control over the economic processes of the nation, with greatest emphasis placed upon expansion of productive facilities.

Recalling that the U. S. experienced a 75% expansion in productive capacity during World War II, Mr. Keyserling forecast the possibility that such an expansion might be repeated. A 75% expansion in the present U. S. economy of $280 billion would bring total production of goods and services in the nation to around $500 billion by 1955, he observed. There is no fundamental reason, Mr. Keyserling indicated, why such an apparently fantastic expansion might not take place. Even a 25% expansion in productivity during the coming five-year period would bring U. S. economy to a $350 billion level, he pointed out.

Three Others

While not soaring to such heights of speculation, three other Government spokesmen developed the same "expansion" theme in late-October addresses. Secretary of the Interior Oscar Chapman urged members of the Electric Utilities Industry Defense Advisory Council to make plans for an even greater expansion of electric energy generating capacity than they have previously considered.

First of two Government spokesmen to outline the expansion policy on steel was Clarence J. McCormick, Undersecretary of Agriculture. Speaking before a meeting of Southwest Implement Dealers at Vincennes, Indiana, he said that "the long-term record of steel requirements shows a capacity of 118 to 123 million tons will be needed by 1953, even for civilian use."

Just to make the Government's position official, there is also a statement by W. Stuart Symington, chief, National Security Resources Board. On October 23 Mr. Symington said he was convinced that the steel shortage was not temporary in character, or regional in effect. He added that all classes of business were complaining, but that he would reserve decision on the proposed expansion program until a report now in preparation by the Commerce Department is released.

First M Order

The importance which NPA attaches to steel is indicated by the fact that its first M order (dealing with materials) is in that field. Orders covering other materials are expected to follow soon—probably covering aluminum, copper, zinc and lead. During World War II the first M order controlled aluminum, and M orders controlling magnesium, ferro-tungsten, neoprene, synthetic rubber, nickel-bearing steel, nickel, copper, zinc and pig iron preceded the steel order.

Lead Time Fixed

Lest you may have forgotten, orders issued in the early stages of World War II were of four types—preference rating orders, allocation orders, conservation orders, and limitation orders. Preference rating orders, called P orders, were blanket priority ratings given specified industries. Allocation orders, designated as M orders when they dealt with materials, and E orders when concerned with equipment, controlled the flow of materials and machinery to industry. The conservation orders, also in the M series, restricted the uses to which a given material might be put. Limitation orders curtailed the production of certain end products.

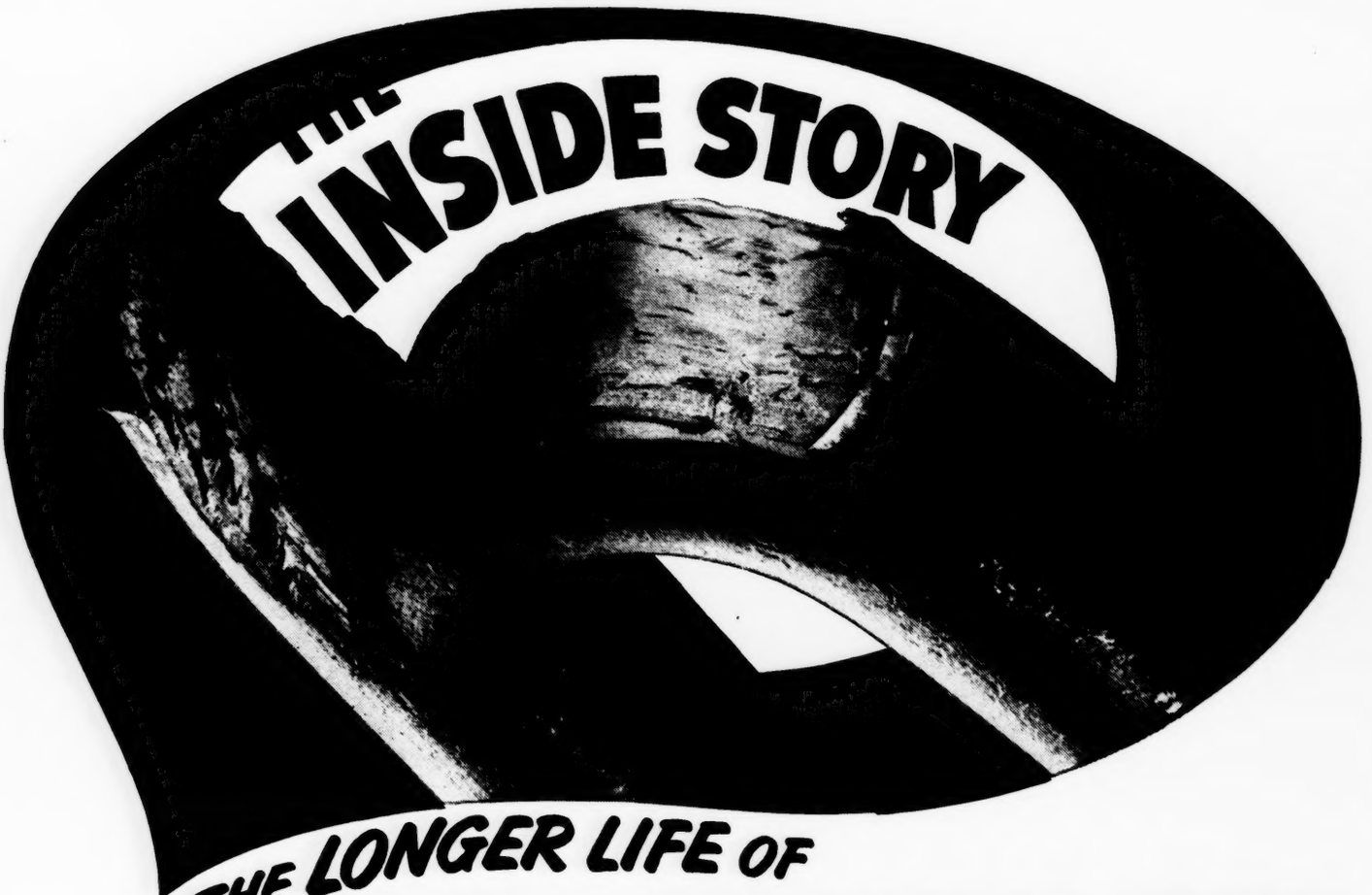
Another difference between the present program and that in 1941 is the fact that the NPA started its program on September 18 with an inventory control regulation (NPA Reg. 1), whereas the M orders in 1941 carried their own provision regarding inventory control of such materials. The OPM issued its first inventory control plan in May, 1941, under the title, General Metals Order No. 1, applicable to 16 metals and groups of metals. The order was later amended to include others.

The National Production Authority's new order (M-1) is intended to assure equitable distribution of defense orders among steel producers and to prevent overloading of an individual plant. The order provides a "lead time" of 45 days before the first day of the month in which shipment is requested, and sets a ceiling on the amount of defense orders which a producer must accept in any one month.

Under the order, no producer shall be required to accept defense rated orders for a total tonnage of all products in excess of 15% in the case of carbon steel, and 25% in the case of alloy steel, of his schedule production of ingots in any one month. The 45 days "lead time" specified in the order indicates that the defense program will make no substantial inroads upon the steel industry until final weeks of 1950 or early 1951.

Entire Production

Through Order M-3, the National Production Authority has taken over the entire production and use of columbium-bearing stainless steels for the defense program. The action was taken because ferro-columbium and ferro-columbium-tantalum, which are

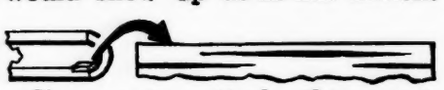


OF THE LONGER LIFE OF BYERS WROUGHT IRON

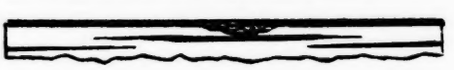
Every engineer will recognize this picture as a notch-fracture test specimen . . . and will appreciate the unusual physical properties suggested by the break.

The hickory-like fracture results from the unique structure of wrought iron. Tiny threads of glass-like silicate slag, 200,000 to 250,000 per square inch of section, are distributed through a matrix of high-purity iron. This fibrous structure, which might be compared to that of a stranded wire cable, equips wrought iron to withstand sudden shock, and to resist fatigue induced by continuing vibration.

Of even more importance in the average application is the *corrosion resistance* of wrought iron . . . which also comes directly from the unique structure and composition of the material. If a small section of wrought iron were placed under a microscope, a few of the multitude of silicate slag fibers would show up as in this sketch.



If corrosion attacks this specimen, it would first cover the entire surface . . . then concentrate at one point, and work inward. Soon it would encounter one of the slag fibers . . . and since this fiber is unaffected by corrosion, the inward march would be halted. This action is shown by this sketch.



Corrosion is now "detoured." It works right and left, until it comes to the end of the fiber, when it may start to work inward again. The process is repeated when the second line of defense is encountered. Pitting, and rapid penetration of the metal, is discouraged. Useful life is determined by how long it takes for corrosion to reduce the entire body of metal to its safe limit of thickness, rather than by how long it takes corrosion to perforate the wall at a few vulnerable points. The fibers also anchor the initial protective scale, which shields the underlying metal.

Every cost sheet today confirms the fact that the most expensive material you can use is that which must be replaced too soon—and too often. The extra service of wrought iron is helping tens of thousands of users to cut maintenance costs. We will welcome an opportunity to review your piping problem with you—and to recommend the places where wrought iron—on the basis of its past performance—can be profitably used. Ask for our booklet, "THE A B C'S OF WROUGHT IRON."

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CORROSION COSTS YOU MORE THAN WROUGHT IRON

WROUGHT IRON

TUBULAR AND HOT ROLLED PRODUCTS

ELECTRIC FURNACE QUALITY ALLOY AND STAINLESS STEEL PRODUCTS

used for producing columbium stabilized stainless steels, are in short supply and are required for the defense program. These alloys are used primarily in high-combustion chambers and in the processing of certain chemicals. They are not used in the production of consumer-type goods.

Rubber Order Out

On October 20, the NPA issued its new rubber order (NPA Order M-2) applying to use of new rubber during the months of November and December. A new order will be drafted to become effective for the year 1951. The present order limits the use of new rubber, both natural and synthetic, to 84% of amounts used in a base year period ending June 30, 1950. In effect, it limits consumption to the total intended in a previous order (R-1)—about 90,000 tons a month. Instead, industry has used rubber at the record rate of 110,000 tons a month during June, July and August.

For the time being, NPA has rejected suggestions that a ban be placed on the furnishing of a "fifth tire" with new automobiles. The proposal is expected to receive greater consideration when the new 1951 order is drafted. In any event, it tips off the type of Washington thinking going on when rubber is mentioned.

Construction Ban Soon

Reporting a growing feeling that it is unfair to curtail construction of new homes while still permitting construction of such facilities as race tracks, dance halls and other amusement places, the National Production Authority on October 18 forecast the early issuance of a construction limitation order.

Industry representatives attending the meeting are understood to have protested that the curtailment of home building through credit controls, and the trimming of commercial building through a new limitations order, would cut the construction industry too deeply.

Industry folks have estimated that the new credit regulations would cut home starts to between 400,000 and 600,000 next year. NPA officials estimate that starts would be nearer 800,000 to 850,000, which, they observe, would still represent a mighty healthy home building industry. They also estimate that if the credit regulations taper the housing program down to some 800,000 starts, new-construction phases of the defense program will be ready to take up the slack.

The new construction credit controls apply only to one- and two-family houses for the present, although multiple housing and commercial construction control is contemplated. The regulations, announced jointly by the Federal Reserve Board and the Housing and Home Finance Agency, became effective on October 12. The regulations call for down payments ranging from 10% in the $5,000-and-under range to 50% for those valued at $25,000 and over.

MEA Backfires

As late as October 20, it appeared that one plan for administration of national defense activities had misfired. The Interior Department had announced plans for the formation of MEA, the Minerals and Energy Administration. Later, Secretary Chapman announced his decision to create four agencies to handle, respectively, electrical energy, solid fuels, petroleum, and minerals.

The change of pace indicates that none of the four classifications dared risk being placed under a single agency which might be headed by someone representing a competing classification. The coal group, for example, did not care to be under an administrator from the oil classification, and so on. It is anticipated that the MEA initials—Minerals and Energy Administration—will be only a term loosely designating the four Interior Department Agencies.

Field Offices Ready

The 42 field offices of the Department of Commerce are now prepared to provide additional local guidance to businessmen on the programs of the National Production Authority and other Department programs, Secretary of Commerce Sawyer has announced. The announcement followed a series of meetings at which regional directors conferred with NPA officials on the administration of the NPA program for securing defense materials with a minimum effect upon civilian supply.

"We are making it possible for businessmen with production problems brought about by the rearmament program to find help close at hand," said Secretary Sawyer. "Unnecessary trips to Washington are not only expensive and wasteful, but also add to the burden of an already strained economy. In most instances, field offices will be able to answer specific questions regarding programs as they are put in effect."

Stoker Sales Up

The Census Bureau of the Department of Commerce reported in mid-October that factory sales of mechanical stokers continued through August the upward trend which began in April. The total rose 93% from 2,452 units in July to 4,725 units in August. All classes of stokers except class 5 (large industrial high-pressure steam plants) shared in the July to August advance, with residential stokers showing the largest gain—from 1,774 in July to 3,593 in August. Sales of stokers for residential use, small apartment houses, and small commercial-heating jobs (classes 1 and 2) accounted for 83% of the numbers sold. Despite the upward movement noted since April, sales in the first eight months of 1950, at 13,697 units, were still trailing the 19,652 sold in the comparable period of 1949.

Significant increases were shown in shipments of all types of nonelectric heating equipment during August as compared with July, according to the Census Bureau. Preliminary figures for August, were as follows: cast iron boilers, 40,329,000 lb shipped, valued at $8,175,000; cast iron radiation, 6,449,000 square feet, $3,506,000; oil burners, 138,749 units; warm air furnaces, 146,653 units, $27,084,000.

BRIEFLY STATED

• A mobile laboratory, for checking new applications of warm air heating throughout the country, features electronic testing and recording devices to be operated by the field investigation committee of National Warm Air Heating and Air Conditioning Association. Resulting information will be used by the installation codes committee to assemble design and installation standards for newer types of installations.

• Bituminous Coal Research will spend more than $400,000 in 1951 on research, exclusive of its program to develop the coal burning gas turbine locomotive and improved mining equipment. More efficient combustion and control of bituminous coal burning equipment, including a new type of completely automatic stoker with bin feeding and mechanical ash removal, will be the object of investigations under this program.

• ASHVE has signed agreements for cooperative research in seven colleges and universities covering problems in heating, ventilating and air conditioning. These agreements are for a one-year period during which a grant of funds is made by ASHVE to each institution, which in turn uses its own facilities and faculty to perform the research under the direction of a technical advisory committee.

• Reorganization plans for Drayer-Hanson, Inc., have been completed and approved by stockholders. Plans include issue of new common stock in lieu of outstanding Class A and common shares, according to George J. Morton, recently elected president.

• The 1950 West Coast refrigeration and air conditioning educational exhibit and conference, to be held at the Municipal Auditorium, Long Beach, California, November 17, 18 and 19, will include exhibits and technical papers and will be held concurrently with the 13th Annual Convention of the Refrigeration Service Engineers Society.

• The second research correlation conference under sponsorship of the Building Research Advisory Board will convene at the National Academy of Sciences in Washington, November 21, and will cover fire resistance of exterior non-load-bearing walls.

• Oil pipe line mileage has increased by 25,463 miles in the period from May 1, 1941 to January 1, 1950 to a total length of 152,814 miles. Average diameter of crude oil trunk lines has increased from 8.4 to 9.8 inches during this period, according to an information circular published by the Bureau of Mines.

• At a special meeting of the directors of Iron Fireman Manufacturing Co., held September 5, after the death on August 31 of President T. H. Banfield, it was decided to continue present officers under present titles until the next annual meeting. Frank S. Hecox, general vice president and treasurer, will be chief executive officer of the company during the interim.

• Nearly a quarter of a million dollars has been invested by the Institute of Boiler and Radiator Manufacturers in the School of Modern Heating. This is a mobile three-day school which so far has been held in 20 metropolitan centers in 12 states. For the last 10 years the Institute has spent $20,000 annually on this program, including I-B-R research at the University of Illinois.

• President Truman signed into law October 22, a bill to continue and expand the government's research program in the production of synthetic liquid fuels from coal under the direction of the Bureau of Mines. The bill extends the Synthetic Liquid Fuels Act of 1944 until April 5, 1955. Funds authorized under the program are increased from $60 to $87.6 million. Of this, a sum not to exceed $2.6 million is set aside to construct and equip an experiment station at Morgantown, W. Virginia, as a research laboratory in the production of liquid fuels from coal.

• Chilled water risers for a new air conditioning system on the old 25-story Herald Square Building in New York will be run up inside stainless steel jackets on the exterior of the structure. Branch lines into corridors of each floor will be hidden behind new furred-in ceilings. Turbine driven compressors and pumps will be housed in the basement and sub-basement.

• The Detroit Edison Co. will build a new 400,000 hp electric generating plant on the St. Clair River between Marine City and St. Clair at a cost of more than $35 million.

• High speed screening of temperatures by an electronic monitoring instrument was described by W. E. Belcher, Jr., of Minneapolis-Honeywell at the fall general meeting of AIEE. The instrument detects unsafe temperatures in machinery, announces the occurrence, and records the information. Tube and boiler temperature in central stations can be scanned in from 2 to 10 seconds per point. Other applications are for flue gas temperatures, atomic pile temperatures, and various process system temperatures.

• The Hotpoint House of the Fifties, opened October 11 in Plandome Mills, N. Y., features summer and winter air conditioning by General Electric, and an all-electric automatic kitchen and home laundry. It is said to be the most electrified house in the country.

• Replies to a questionnaire sponsored by the Instrument Society of America and circulated through the National Steam Specialty Club indicate that control valve manufacturers are able to supply flanged control valves according to uniform face-to-face dimensions. ISA says this is a first step toward standardization of these dimensions.

• Howard L. Spindler has been named director of public relations of the American Radiator and Standard Sanitary Corp. Mr. Spindler has been manager of advertising and sales promotion since 1945. Robert W. Lear was promoted to the position of manager of advertising and sales promotion. Mr. Lear was formerly assistant manager of this department.

Avoid

Timber Rot, Peeling Paint, Crumbling Plaster

Asphalt Paper is Not Vapor Proof—Merely Waterproof

Unventilated walls with ordinary insulations which permit water vapor to seep through, condense and accumulate, can cause damage. Over a million dollars was recently spent in ripping out and replacing crumbling plaster walls in a tremendous brick and steel, nationally known, apartment development in Greater New York.

Vapor, a gas, flows through a wall, including plaster and asphalt, from high vapor density areas to low. Upon reaching a substance colder than its dew-point temperature, it condenses.

"Dew will not form on the walls and ceilings of a well-insulated house. But it may condense in the insulation in the walls or on the siding or sheathing. The insulation and wood then become damp. In time this dampness may cause the wood to rot, and the paint to peel off." U.S. booklet,* "Insulation and Weather-proofing," Page 11, Division of Farm Buildings and Rural Housing.

Multiple accordion aluminum is impervious to vapor and is non-condensation forming. Because of its slight mass, the aluminum sheet on the warm side quickly approximates the temperature of the contacting air; and never falls below the dew-point. Heat flow by inner as well as outer convection is blocked by the fiber and aluminum sheets. The air spaces practically eliminate conduction. The additional aluminum sheets reflect back 97% radiation on the warm side and emit only 3% on the cold side.

Because of low (3%) emissivity, the aluminum on the cold side is slightly warmer than the cold contacting air, so condensation on it is not possible. No dew-point is possible anywhere on or within the insulation.

This construction for walls is available commercially as INFRA INSULATION, TYPE 4 and TYPE 4 Jr. They cost under 7¢ a sq. ft., material with labor, in new construction between wood joists.

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Down-Heat C.064, R15.62 equals 5" DRY Rockwool
Up-Heat C.109, R 9.17 equals 3" DRY Rockwool
Wall-Heat C.105, R 9.52 equals 3 1/7" DRY Rockwool

VAPOR PERMEABILITY equals ZERO

Multiple Accordion Aluminum and Triangular Reflective Air Cells

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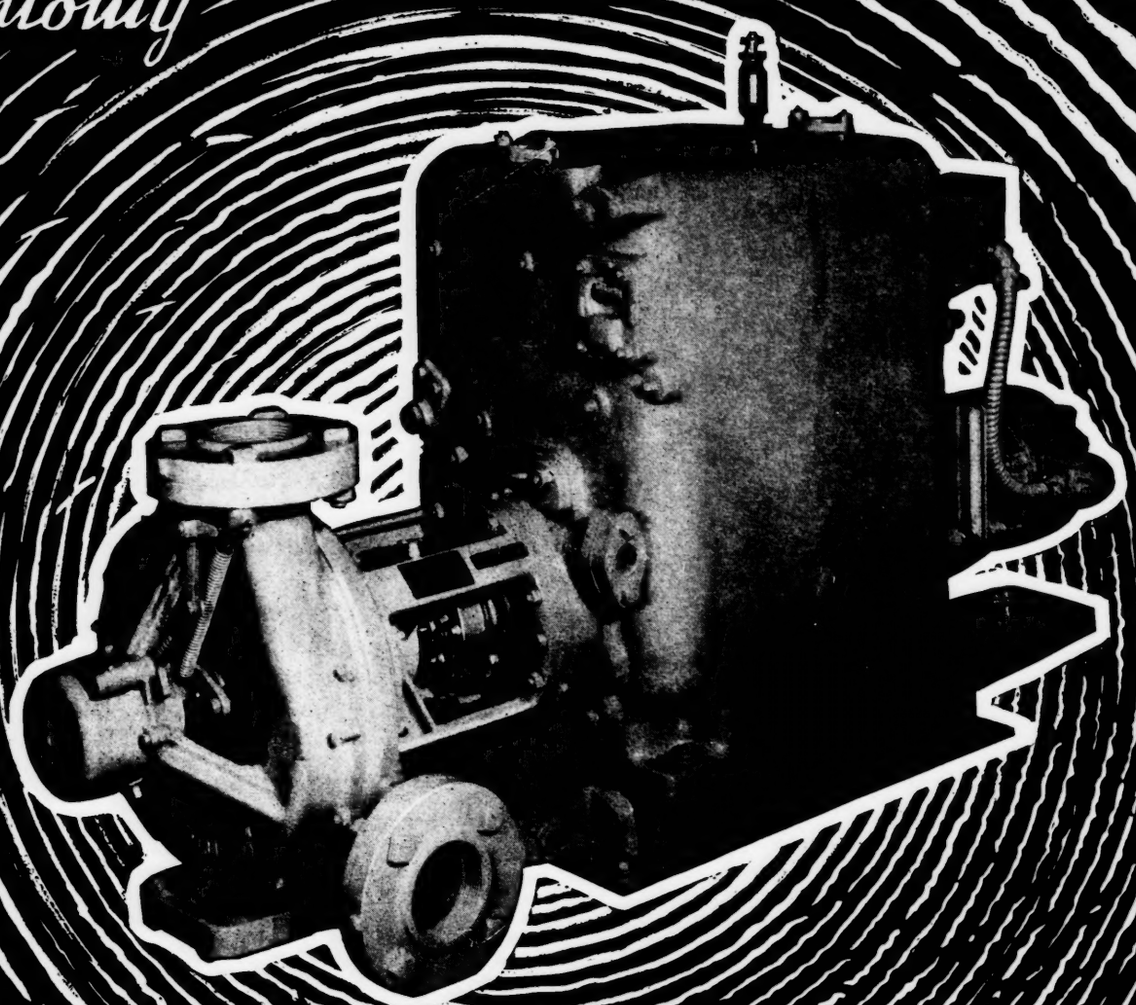


A RETURN LINE VACUUM PUMP THAT CUTS HEATING COST.

This unusual pump needs no electric current, cutting out greatest item of pump operating expense.

More important, this pump insures absolutely uniform circulation in system. That means continuous steam economy.

Simple, compact, one moving element, no wearing parts, no internal lubrication. Bulletin No. 203 gives the facts. Your copy is waiting.

THE NASH ENGINEERING COMPANY
SOUTH NORWALK, CONNECTICUT, U. S. A.

Courtesy Better Theatres.

Ventilating the Small Theater

JOHN J. SEFING
Consulting Theater Engineer
Toledo, Ohio

Small and average size theaters find that the air conditioning system employing refrigeration is too costly for their budget. They must, therefore, depend on simple ventilation. In a very practical manner, an engineer with extensive theater experience discusses the design and installation of ventilating systems in theaters.

EVEN though banners hanging from a theater marquee may proclaim that it is arctic cold in the auditorium, few theaters are really air conditioned. Basically, it is due to the fact that the theater owner and manager cannot differentiate between a true ventilating system and a true air conditioning system.

It must be remembered that most theaters up to 800 seats capacity must, of necessity, operate on a very limited budget and cannot afford a costly air conditioning system with refrigeration equipment. The common answer is to install a simple ventilating system that can provide a reasonable amount of comfort.

Ample Capacity Important

Extreme care must be taken that the many items that make a forced-draft ventilating system an efficient year-round system are not overlooked or neglected. The engineer should never provide for a smaller amount of air than will be actually needed at any period of maximum requirements.

When a blower is installed that delivers a small volume of air, even with almost perfect distribution over the auditorium, a bad condition will result at the rear and theater entrance. Air as it leaves the deflector at the front of the stage picks up heat, moisture and odors in its travel over the patrons. This odor-laden air goes through the entrance lobby and is disagreeable to the incoming people. To prevent this condition, a greater volume of air must be delivered inside the auditorium so that the air will seem fresh and not unduly warm in summer. In some localities 30 cfm per person are prescribed by law for minimum ventilation. However, from experience in theater ventilation, 75 cfm per person must be delivered to achieve an agreeable condition within the auditorium on hot, sultry days and to have a reasonable amount of evaporative cooling effect. Calculations for the cfm of air required should be made on the total number of seats, rather than on the cubic area of the auditorium.

The ventilating system should be so planned that the flow of air is from the deflectors at the stage, across the length and width of the auditorium, then to the outside by means of exhaust ducts at the rear. A ventilating system for an 800 to 1,000-seat theater is illustrated in Fig. 2; a ventilating system for a 400 to 800-seat theater in Fig. 3. The deflectors that are used should be of the type that have blades that can be adjusted vertically and horizontally for properly directing the air flow to any portion over the seating area in the auditorium. Exhaust ducts should have a fan or a blower to pull out the stale air which will accumulate at the rear, especially where there is a balcony. The main thing is to have a continuous flow of air in the auditorium, from front to back, so that the heat and moisture can be exhausted to the outside. In no case should the opening of lobby and exit doors be depended upon as a means of exhaust.

Areas below and above a balcony, especially where there is a low ceiling, are usually very hot and stuffy, both summer and winter. Patrons seated under such conditions will soon find it impossible to enjoy a picture regardless of its entertainment value. Therefore, exhaust fans or blowers at the rear of the auditorium, with or without a balcony, must be considered neces-

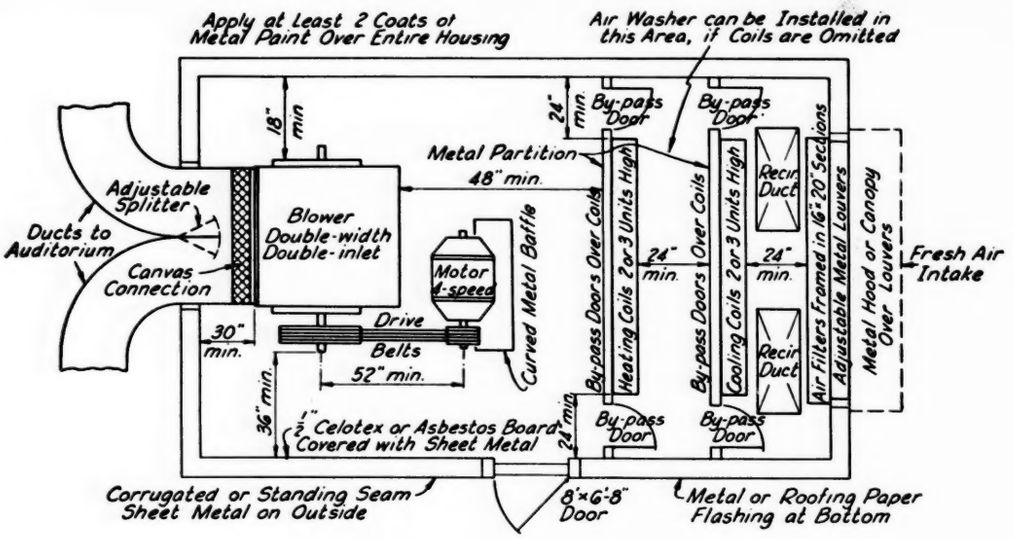


Fig. 1. Recommended layout of blower room for proper installation of ventilating equipment.

sary for true ventilation. Where the balcony has a large seating capacity, it is important that fresh air flows continuously over the area by means of separate deflectors installed at the stage to supply only balcony air. In the average size theater, the bottom of the fresh air supply deflector should be placed at the stage 9 to 10 ft above the auditorium floor. Best results will be obtained, for the air will move directly over the patrons' heads—not low enough to blast them in the face nor too high to reduce the picking up of heat and moisture.

Blower Room

It is very important that good provisions are made for the blower room. Equipment must be near the stage and properly housed, and a free, unobstructed fresh air intake provided. This intake should not face a coal yard, restaurant kitchen, chimney, railroad or sidewalk. No general rule can be given for the best location of the blower room, for each theater has its own specific problems. The blower room has been located on the roof over the stage; where the stage is small, it is placed outside of the building at the rear; in some theaters, the only available space is under the stage in the basement. There is an advantage whenever the blower room is located within or close to the auditorium at the stage end. It reduces the run of ductwork, allows more air per unit of blower capacity, and reduces the amount of housing and duct insulation if heating or cooling coils are installed.

Where a theater auditorium is quite wide, as in a 800 to 1,000-seat theater, two blower rooms must be provided, one in each of the proscenium wing walls at the stage. From experience it has been found that when auditorium requirements go above 40,000 cfm, it is best to install two separate blowers. By operating one large blower at large output and high velocity, there will be objectionable mechanical hum, vibrations and wind noises. Large ducts will be needed and air distribution will not be flexible. When two separate blowers are installed, each can be operated at slower speeds and with less mechanical noises. Small ducts can be used. Better air distribution results, especially in the late fall or during the winter when less fresh air is required in the auditorium.

When ventilating equipment must be installed on the roof, the roof-carrying members should be sufficiently strong to take safely both the dead and live loads of this equipment. The average weight of the equipment in the blower room—blower, motor, heating coils, cooling coils or air washer, and housing—is around 2,200 lb. Since this weight will be concentrated in a space about 12 x 18 ft, the best location of this equipment is near the theater retaining walls.

Where the blower room is installed outside of the theater, it is best constructed of metal for longer life and the minimizing of fire hazards. The housing core or framework should be built of at least 1½x1½x3/16-inch angle-iron uprights spaced on 20-inch centers. On the outside surfaces should be applied corrugated or standing seam sheet metal. While this core can also be of 2x6-inch wood studs, it should be covered on both sides with metal for fireproofing. On the inside surface of the housing, ½ inch celotex or asbestos board should be applied and over this No. 22 gage sheet metal. The roof should be of the same materials as the walls but with an incline at least 1¼-inch to the foot. Metal or roofing paper flashing should be installed all around the outside where the housing walls meet the roof of the theater or its abutments, to prevent leakage of air or rain. Rough joints in the housing should be thoroughly caulked with asphaltum or metal cement. The entire housing, where exposed to the outside weather, should be painted with at least two coats of a good grade of metal paint, but only after the metal surfaces have been properly treated to receive the paint.

Although the size of the blower room housing should be determined only after the type and quantity of ventilating equipment to be installed is known, it is

TABLE 1—DIMENSIONS FOR BLOWER HOUSING

Blower Capacity, Cfm	Housing Size, Feet			Fresh Air Intake Louver Area, Sq Ft
	Length	Width	Height	
25,000	8	7	7	36
45,000	10	9	8	51
65,000	12	11	9	87

important that the housing be made a little larger than actually required by the equipment. This provides space for any future equipment that might be installed. Suggested blower room sizes are given in Table 1, and room details in Fig. 1. The fresh air intake louver should have the blades adjustable for different settings, figuring that the fresh air intake opening in the blower housing should be based on the total maximum capacity of air that the blower can deliver. Small or improper housings have been one of the main faults of ventilating equipment installations.

Installation Details

It is important that at least 30 inches be allowed from the mouth of the blower to the wall. This space is essential for duct connections to permit full round bends and proper underhang at the mouth of the blower to enable the air to expand and flow freely. On a double-width double-inlet blower, the closest the non-driving side should be to the wall is 18 inches. On the side where the pulleys and drive belts are installed, at least 36 inches should be allowed for proper servicing and maintenance work. The drive motor should be installed in line with the blower and at the rear of the room, if possible. The centers of motor and blower shafts should not be less than 52 inches. Blower and motor should always be rigidly fastened to substantial bases, lugged to the beams, if possible. Where an air-washer is installed at the side of the motor facing the washer, a curved metal baffle should be placed to prevent drops of water or moist air from striking the windings or wires of the motor. This precaution will help reduce insulation breakdown within the motor and save the contractor unnecessary service work. Blower and motor should have good sound-absorbing bases to cut down mechanical noise transmission.

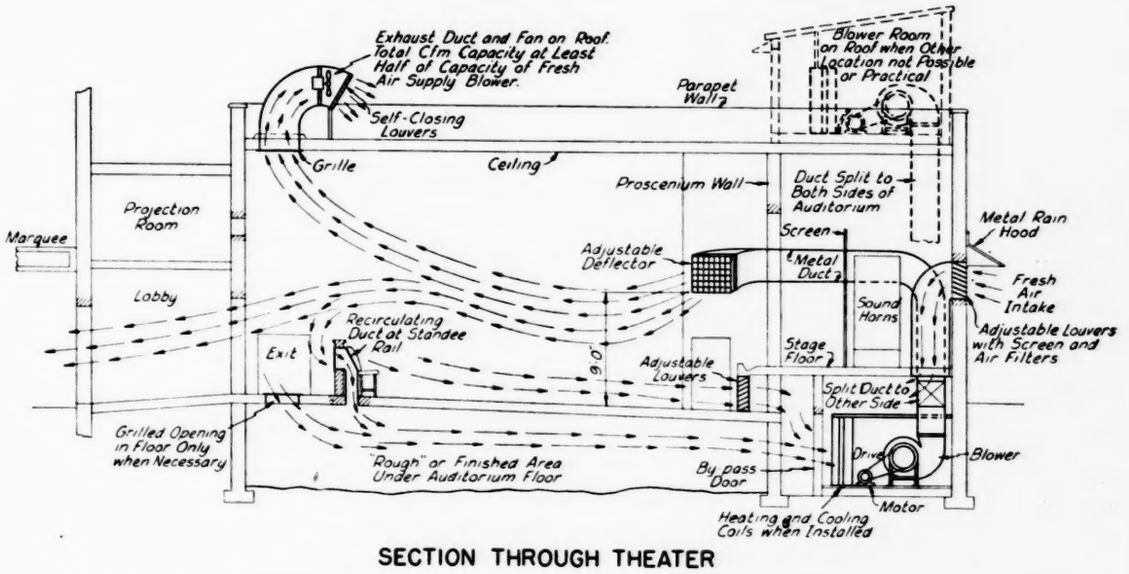
Duct work from the blower supply mouth to the deflector at the stage should be metal, properly reinforced for rigidity and long life.

Extreme care should be taken that no blower will be so close to the auditorium wing-wall, or to the sound speaker system that blower noise could be heard, or that the speaker could pick up mechanical noise.

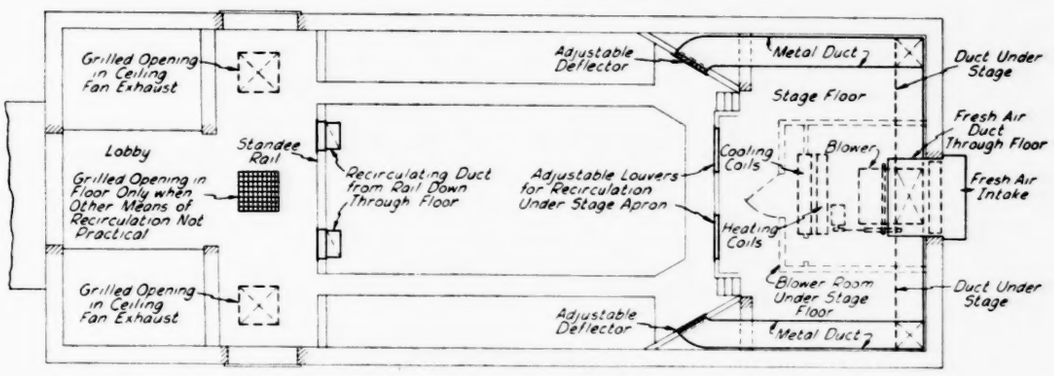
When heating and cooling coils are to be installed in the ventilating system, or such coils are planned for future installation, the coils should be so planned that by-pass doors can be had at each end of the coils. If possible, by-pass doors should be placed at the top of these coils. One function of these by-pass doors is to shunt the air, when they are opened, to avoid pulling the air through the fins of the coils when the coils are not used. This avoids adding resistance to the flow of air. The by-pass doors should have good latches or hooks on them so that they can be fastened rigidly to the wall when they are opened.

Coils and Filters

The exact size of these cooling and heating coils will



SECTION THROUGH THEATER



PLAN OF THEATER

Fig. 2. Typical ventilating system for theaters with 800 to 1,000 seats. Provisions are made for installation of cooling and heating equipment.

depend on the design loads required for the theater. For the average 600-seat theater, each section of the coils will run about 78 inches long, 27 inches high, and 10 inches deep. Usually three such sections of coil are installed, one over the other, in a bank three units high. At least 24 inches of clear space should be allowed at the sides of these coils for convenient check-ups and servicing.

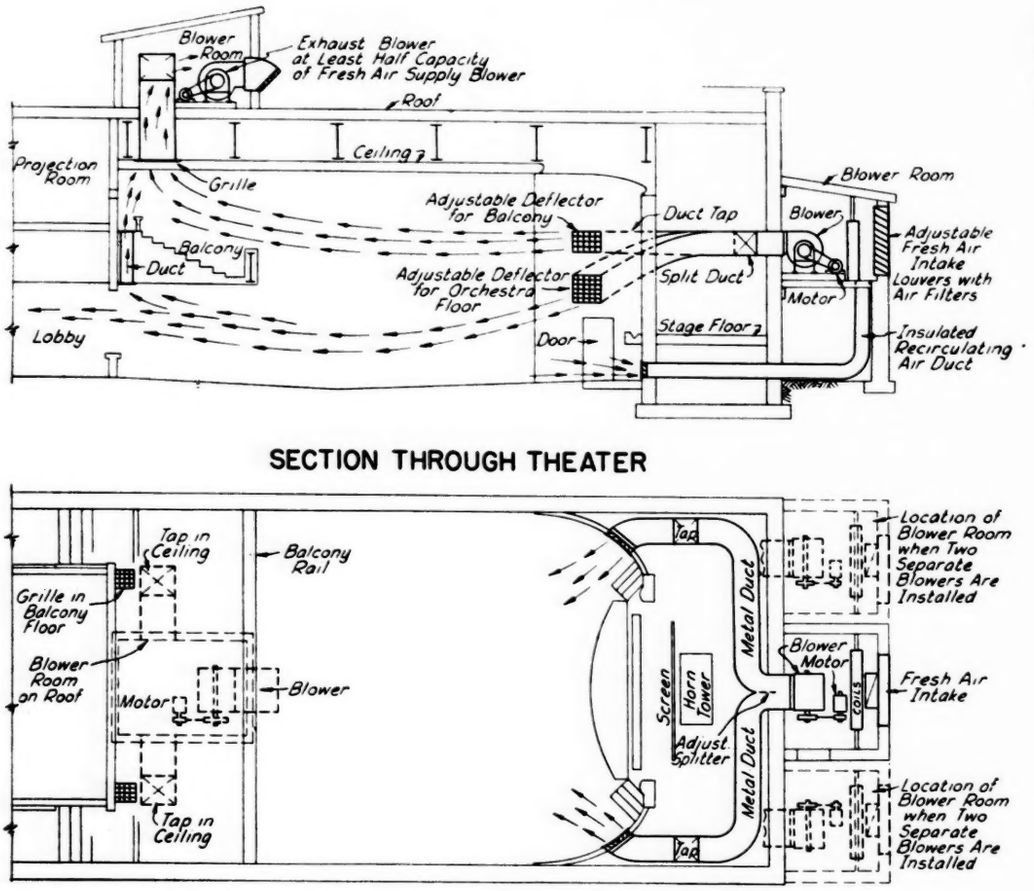


Fig. 3. Typical ventilating system for theaters with 400 to 800 seats. Plans provide for later installation of cooling and heating equipment.

In the ventilating system of the average size theater, inexpensive throwaway air filters are usually installed in the fresh air intake louvers to filter out particles of dust, dirt and other small foreign bodies present in outside air. However, where the standard paper oil-impregnated filter, or the washable, permanent type air filters are installed—16 by 20 inches—the size of the fresh air intake opening in the blower housing must be carefully considered. In other words, the clear area of the fresh air intake opening required by the capacity of the blower should be enlarged according to the over-all dimensions.

It is important that a rigid framework be installed to hold all these filters in place, and that substantial cross-members be used to keep each unit from being sucked out of position. In the past, constant trouble was experienced where these filters were installed in poorly designed frames and weak or makeshift cross-member reinforcings. Since the blower pulls air into the housing at a high velocity, these filters must be fastened rigidly in place. Otherwise, they will be sucked away from the framework. To be on the safe side, the iron framework and reinforcing cross-members should always be purchased from the manufacturer supplying the air filters. Where space in the blower housing permits, the air filters and framework should be installed a little away from the fresh air intake louver so that rain or snow will not beat directly into them.

Louvers should be adjustable so that they can be regulated according to outside weather conditions. Directly over fresh air intake louvers, a substantial hood or canopy should be placed to help deflect direct penetration of rain or snow into the filters. A wire mesh screen guards against the entrance of other foreign material and insects when the louvers are opened wide.

Motor for Blower

The blower drive-motor should be a two-speed, multiple-speed, or slip-ring variable speed unit to allow adjustment in the volume of air delivered to the auditorium according to changes in the weather and theater requirements. Although a single-speed motor may be cheaper in initial cost, when colder weather sets in it will be almost impossible to use, because of the terrific volume of cold air that will be delivered, at high speed, to the auditorium. Mostly all power companies require that motors 5 hp and larger be connected to 2- or 3-phase a-c circuits. This practically eliminates single-phase a-c motors from consideration

for ventilating systems. Furthermore, single-phase a-c motors are made standard single-speed and a special single-phase motor for multi-speed work would be almost prohibitive in cost. If single-phase, single-speed motors must be used, flexibility in speed can be attained by installation of hydraulic or mechanical variable speed drives. These are not as efficient, however, as multi-speed motors such as a 4-speed motor which is the most practical for ventilating system use. The multi-speed features apply to the exhaust fan or blower motor, since there will be times, especially in winter, when it will be desired to remove only a small amount of air from the auditorium.

Duct Work

Ducts should always be of ample size to carry the required air. They should be rigidly supported and braced by angle-irons or other means to avoid objectionable noises.

In many ventilating systems where duct trouble occurred, it was noticed that loud banging noises could be heard every time the blower was turned on or off, due to the expansion and contraction of the air flow. Where sharp right-angle bends must be placed, it is best to install a series of small splitters within the bends to help ease the air flow. Where taps are taken off the main duct system, adjustable dampers should be installed at the junction of these taps for proper air flow regulation. It is a good plan to insulate the duct work, especially where exposed to the outside air, with 2 or 3 layers of roofing felt paper, and all joints, where necessary, caulked solid with roofing cement. Much air can be lost by seepage through poorly made duct joints and this hampers the good performance of the ventilating system.

Where one blower supplies air to both sides of the auditorium through a split duct system from the mouth of the blower, Fig. 2, an adjustable damper, rigidly supported, should be installed at the split for positive control of the air to each branch duct. This damper becomes very important where it is found that one side of the duct system has more resistance pressure or when more air is to be sent to one side of the auditorium. In every case, a canvas connection should be installed between the mouth of the blower and the duct, not only to help prevent the transmission of mechanical noises from the blower, but to help the expansion of air as it spills off the squirrel-cage blades. This canvas duct connection should be a strip not over 8 inches wide and installed as airtight as possible. Another good idea is to have the bottom side of the supply duct about 6 inches lower than the bottom of the blower mouth opening for the proper expansion of the air before it is forced into the duct system.

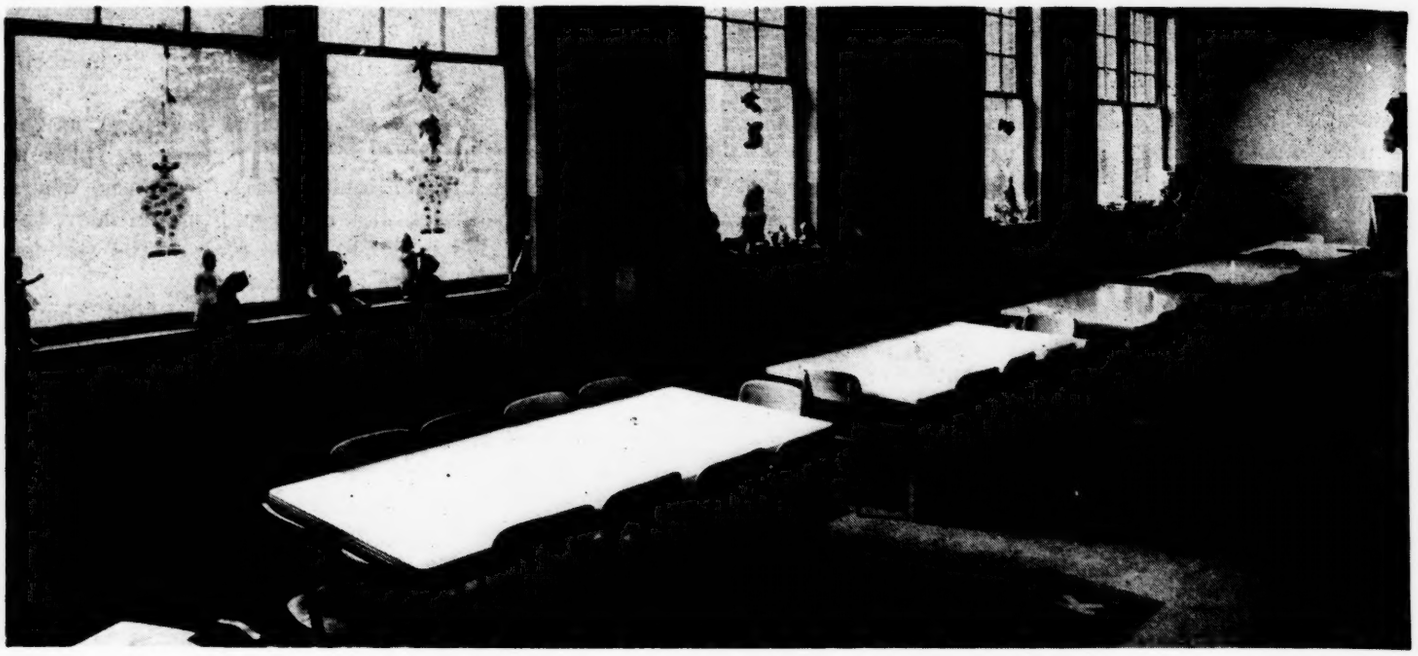
A recirculating air duct system is very rarely used in a simple or straight ventilating system except where there are provisions for heating or where an air conditioning system may be installed in the future. Neverthless, every simple ventilating system should be planned so that it will not be a very costly job to later add heating facilities, air conditioning, or air-washer. Where air conditioning is used, cold water is nearly always supplied from a well, for a compressor system is prohibitive in cost for theaters having from about 400 to 800 seats. A recirculating air duct system is usually run from the front apron of the stage, as the average-size theater has no basement or plenum chamber under the auditorium floor. However, where there is an open area under the auditorium floor, the air is recirculated both from the rear of the standee rail and the front stage apron.

Every ventilating system, upon completion, should have proper adjustments of the fresh air supply blades so that there will be a correct flow of air throughout the auditorium. Although the ventilating system is of the proper type and size for the particular needs of the theater, if the air is not distributed evenly throughout the auditorium, the system is not doing its job. Improper air distribution, particularly air flow over the patrons, is the major complaint of 90% of theater ventilating systems. It is proper and efficient air flow within the auditorium that labels a simple ventilating system as satisfactory. This is the important reason that the fresh air supply grille or deflector should have efficient blades and ease of adjusting the air flow both vertically and horizontally.

Adjusting the Deflector Blades

In adjusting the air flow within the auditorium, the following procedure has been found to be very effective. The supply blower or blowers and the exhaust fan should be turned on full-blast to obtain conditions within the auditorium as near normal operation during show hours as possible. Two or three persons should then sit in different sections, beginning at the front row—but always in the same row. Each one should hold in his hand a toy pinwheel or a stick with a streamer of silk or other light material attached. One man should be at the F. A. supply grille or deflector, or one at each of the grilles if two F. A. supply grilles are installed. They should be ready to adjust each individual blade as directed.

The men sitting in the auditorium seats should lift the pinwheel or streamer stick about 18 inches above their heads, and when the pinwheel begins to turn or the streamer begins to lift, notify the men at the F. A. supply grilles. After the front row of seats is done, the men should move to the fourth or sixth row, and so on, until the entire seating area has been covered. Care should be taken by the man at the F. A. supply grille that he does not move the blades too much, either vertically or horizontally, for an inch in either direction will deflect the air flow substantially. When these adjustments are completed, the blades should be locked tightly in place. This does not mean that the air flow has been perfectly adjusted forever. Some changes will be advised for a full audience, due to heat and moisture given off by the patrons. Dead spots should be checked carefully. The blades controlling each particular spot should be turned ever so slightly until a movement of air is felt in that area. Two or three such adjustments are necessary, in some cases, before a relatively even air distribution in the auditorium is accomplished.



Kindergarten room of St. Ann's School, Fair Lawn, N. J., with wall to wall steam convectors.

Wall to Wall Convector Radiation for School Buildings

D. F. BENNETT
Warren Webster & Co., Camden, N. J.

This is the fifth of a group of articles dealing with various methods of heating schools. Previous articles, each by a different engineer-specialist, have covered forced warm air, radiant, convector, and unit ventilator systems. This month's discussion is of the elongated, finned tube, wall type convector in school applications.

THE current record volume of design and construction of new school buildings and extensions, and modernization of existing buildings has occurred during a period when construction costs were at a peak. As a result, there has been intensive searching for ways to do the heating job at least cost, and yet do the kind of quality heating job essential for our schools. Probably no single element has contributed more to meeting these requirements than the extended fin and tube surface or wall to wall convector units developed during the past several years. Some of these units are made with steel tube and steel fins. Others are made with copper tube and copper fins and still others, with copper tube and aluminum fins.

One of the reasons for the widespread growth of this type of heating surface is that it supplies with a few ounces of weight that which formerly required many pounds of iron pipe coils or cast iron radiators. Being of less weight, cost of shipping and labor of handling is greatly reduced. The old familiar skid, used by workmen to move heavy iron radiators, is no longer required for a school heating installation.

From the standpoint of the designer (both architect and engineer) this new radiation development has many application possibilities in modern school design and construction. It takes up less space when mounted exposed or with an appropriate enclosure. It may be built-in under windows. The small cross section makes possible a variety of concealed applications.

This new type of radiation can be arranged to spread the heat the entire length of the window or exposed side of the room, thus making possible the application of the principles of perimeter heating which have been widely used and thoroughly proven in residential baseboard heating. By spreading heat along the full length of the exposed wall, hot spots and cold corners are eliminated. A blanket of warmth forms a barrier between the cold wall and students. This is of particular benefit where window ventilation is used. The constant upward movement of a mild warm air current diffuses and tempers the cooler outdoor air, minimizing the problem of drafts.

One of the important advantages of this type of radiation for school heating is that it lends itself particularly well to the requirements, peculiar to schools, for quick changes in heating combined with continuous comfort.

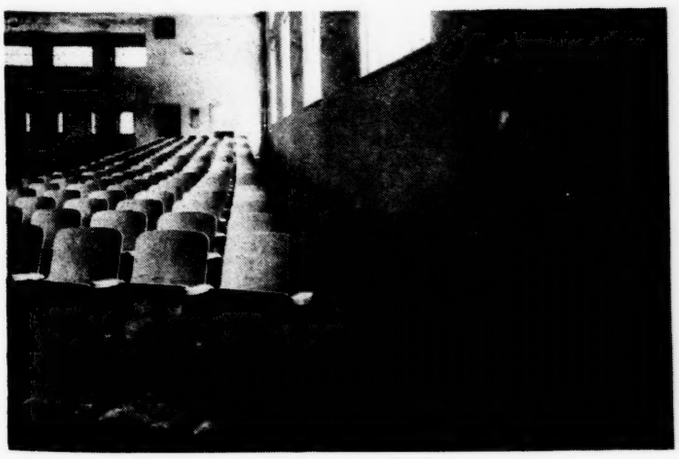
An unusually wide range of heating requirements are found in the individual classroom. These are due to sudden changes in occupancy and also to the effect of solar radiation. The quick response of lightweight extended fin and tube radiation is helpful in meeting these classroom requirements.

If one considers the over-all requirement of school heating, the design objective must be for a heating system which can be turned on as short a time as possible before the building is occupied and reduced immediately occupancy is ended. Heat lag due to massive cast iron radiation or concrete panels does not meet this requirement and results in a waste of costly fuel. It is obvious, therefore, that the quick heating characteristics of this new radiation development are a decided help to both comfort and economy.

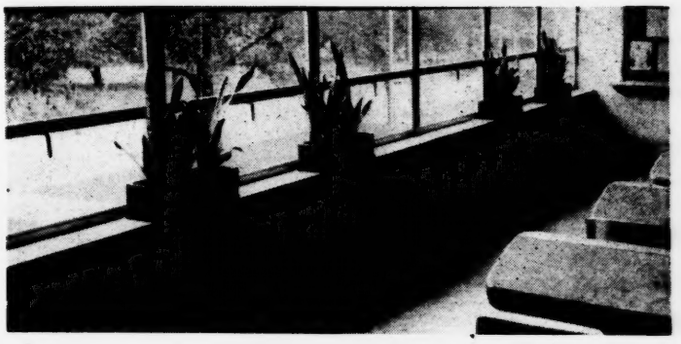
Wall to wall radiation placed low in a room provides both floor surface temperatures and air temperatures that are warm and comfortable, sufficient even for kindergarten classes. In fact, some of the country's most prominent school architects, who resorted to floor panel heating later added wall to wall radiation in order to provide better and quicker heating-up. With further experience, they have now abandoned the floor panel heating entirely and are doing the entire heating job with low placed wall to wall extended radiation. The radiant heat rays from the extended surface are directed toward the floor along the full length of the wall and this, in conjunction with the gentle movement of the room air across the floor into the radiation inlet, produces comfortable floor temperatures regardless of whether the floor slab is directly on the earth, or whether there is a heated space below the floor.

Wall to wall radiation is equally adaptable to steam or hot water. A typical example of the flexibility was afforded by a recent instance in which a parochial school was able to heat a hitherto unheated basement room for kindergarten use, although the basement room is so located that steam could not be supplied to low placed radiation. A heat exchanger installed in the steam boiler and a small circulator provided for hot water heating for this room.

The perimeter heating principle is particularly well suited to heating single-story school buildings as it permits the combination of the radiation and piping.



Wall to wall convector as high-capacity baseboard in auditorium of the Norfolk Catholic High School.



Wall to wall convectors under windows at the Grace McWayne School, Batavia, Ill.

Recent developments in wall to wall enclosure designs also include added safeguards against dirty walls. The location of the air outlet toward the front of the enclosure and a rubber seal at the rear to prevent air leakage where walls are not true and straight have resulted in the provision of an unusual degree of clean heating.

While it is probable that there is wider applicability of this type of radiation where window ventilation is used, numerous applications will also be found in connection with the buildings in those states that have definite mechanical ventilation requirements. In fact, the combination of extended surface radiation of the wall to wall type helps the ventilation equipment to do a better job than is the case where ventilation equipment is used in combination with older types of convectors or radiators.

When used with low pressure steam, wall to wall radiation may be provided with tube type orifices, so that when any steam is delivered to the radiation, it is delivered throughout the length. This makes it possible to use the continuous flow type of control with its assurance of continuous comfort heating and the quick shut-off and quick heating-up characteristics so well provided by low pressure steam.

While the earlier installations of this type of wall to wall radiation consisted of exposed heating elements or a minimum in the way of a sheet metal cover, more recently improved enclosures have been provided. These are light in weight yet sturdy, and are designed for quick and easy installation. In addition to providing the convector heating surface with an enclosure, they may also be used to conceal the piping, thereby eliminating the expense of concealing piping in furred wall spaces or expensive trenches.

The designer of a school heating system must think in terms of a long number of years. Not only first cost but annual cost for maintenance figures large in Board of Education thinking. Wall to wall radiation requires for its part of the heating job no blowers, fans, or filters. It involves no buried piping but everything readily accessible at little expense.

Because of the relative newness of this development, figures are not available as to the number of schools that have been equipped with wall to wall radiation. However, one manufacturer alone reports 45 installations of this type in Alabama school buildings since 1947, and installations in varying numbers in more than 30 different states.

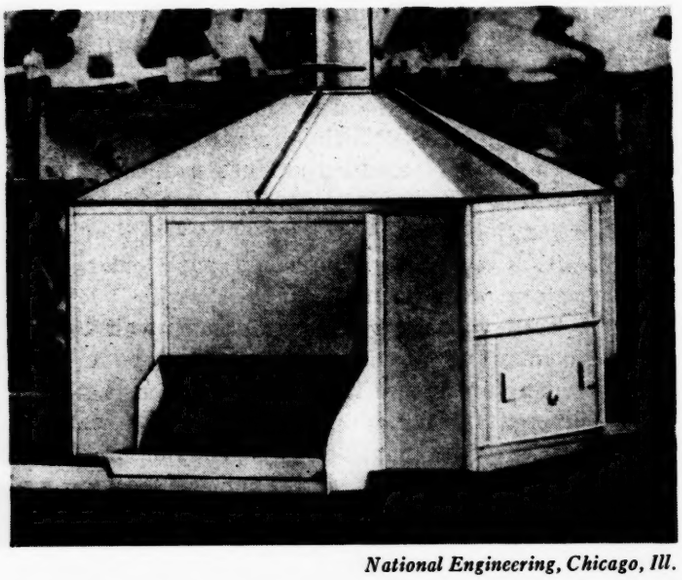
Scrapbook of Exhaust Hood Design

Part 5—Dust Control for Foundry Shakeouts

JOHN M. KANE

Chief Engineer, Dust Control Division, American Air Filter Co., Louisville, Ky.

DUST control for the foundry shakeout has always been an interesting and exacting application of the art of local exhaust ventilation. Dust, fumes, and gases are released with varying degree of intensity as a flask is shaken out. In practically every case, foundry practice differs. Variation in flask size, temperature of sand and casting at time of shakeout, amount of steam and gases released, flow of flask, movement of casting and sand to and from the shakeout, and methods of handling these items provide the variables as control methods are visualized.



National Engineering, Chicago, Ill.

Fig. 1. Complete enclosure with opening for mold feed and casting discharge provides most effective shakeout control.

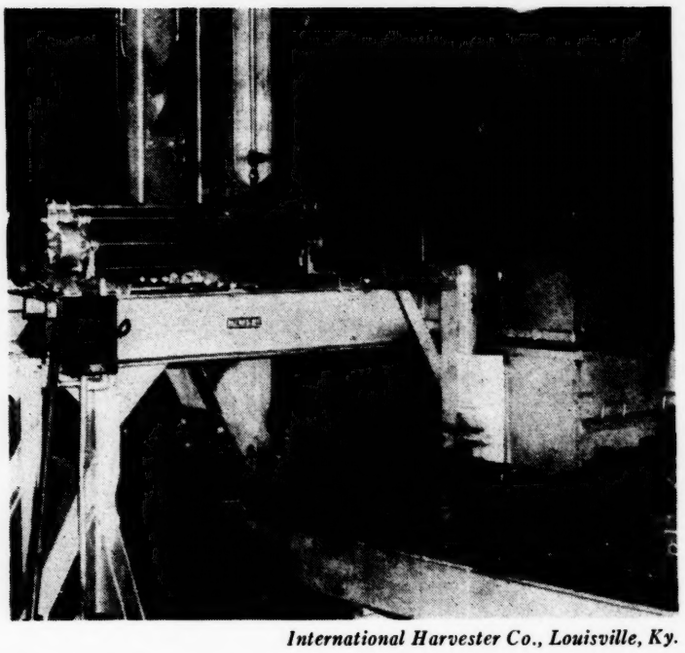
Overhead Hood or Complete Enclosure

Fig. 1 is by far the most effective exhaust hood design. It provides a complete enclosure for the operation, leaving openings on the feed side for flask upsetting, and on the discharge side for casting removal. Exhaust ventilation in such cases involve only the maintaining of sufficient exhaust to provide an indraft of 200 fpm through the existing openings and still enough to handle the surge of released gases as the casting breaks from the mold. A minimum of 200 cfm per sq ft of shakeout grate area is often recommended to provide sufficient exhaust for this induced effect. On some heavy duty production lines where flasks are large, the casting is hot, and the shakeout cycle is on the order of one a minute, minimum exhaust rates could more safely be 400 cfm per sq ft of shakeout area.

Foundry engineers have recognized the positive control that can be provided with hoods of this type. The trend is toward adaption of larger and heavier flasks for use in the modern production foundry. Where snap flasks can be employed, they are removed at the molding station. Automatic flask pushers, Fig. 2, were soon developed to dump sand and casting onto the

International Harvester Co., Louisville, Ky., and National Engineering, Chicago, Ill.

Fig. 2. Snap flask work in mechanized foundries is readily adapted to mechanical upsetting and overhead hood type of dust control.



International Harvester Co., Louisville, Ky.

Fig. 3. Flask pusher, air or hydraulically operated, eliminates manual handling of heavy flasks and positive overhead hood type of dust control.

Steadman Foundry & Machine Co., Aurora, Ohio

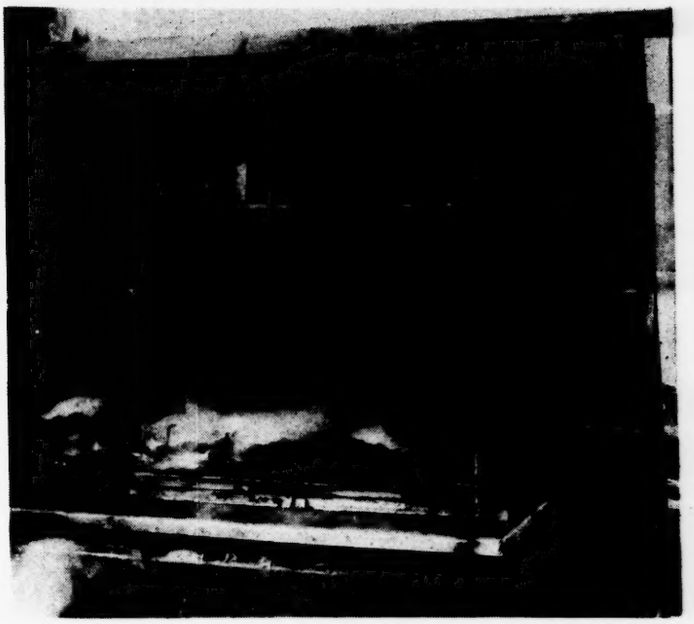
Fig. 4. This modification to the overhead hood design retains advantages of such construction without interfering with flask handling by monorail.

International Harvester Co., Memphis, Tenn., and Kirk & Blum Mfg. Co., Cincinnati, Ohio

Fig. 5. When castings can be discharged from shakeouts to gathering conveyor under the floor, better housekeeping is obtained.

vibrating shakeout, holding the bottom board in its place on the conveyor pallet. Heavier flasks, however, do not lend themselves so readily to this treatment. Oftentimes the cope must be removed first and then the drag turned upside down to free the casting. Where such upsetting is done manually, the front side of the hood requires large open areas to provide space for the workman on each side of the shakeout. This facilitates upsetting and then retrieving the cope and the drag that form the holding box for sand and casting.

Manual operations of this type are hot, hard work, and dust and fume control requires larger exhaust volumes to compensate for the large open areas in the hood. Recognization of this situation has resulted in numerous ingenious designs to mechanically handle such operations. Use of air-actuated tongs and monorail conveyors, Fig. 3, eliminate the manual labor, and



American Manganese Steel, Oakland, Calif.

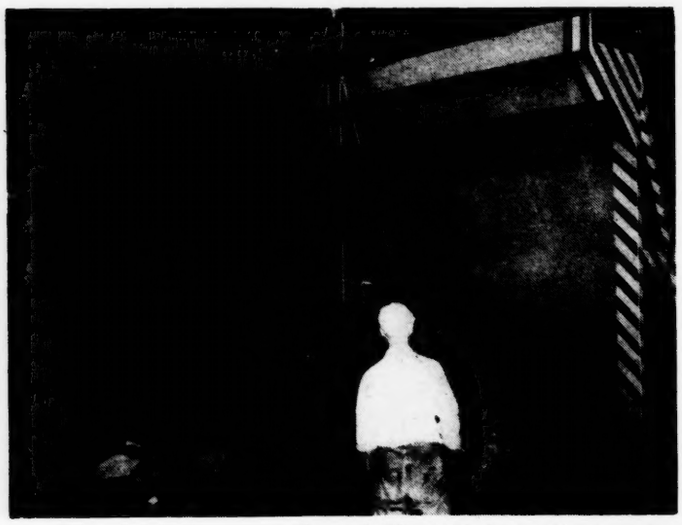
Fig. 6. Side hoods close to the long side of large shakeouts offer best possibilities where overhead cranes are needed to handle flask and casting.

American Air Filter Co., Louisville, Ky.

Fig. 7. Laboratory model studies can evaluate side hood proportions and location of most effective exhaust openings.

aid in more effective hooding. Hydraulic pushers, Fig. 3, automatically push the drag onto the shakeout after large castings have been removed at the casting removal station.

Similar possibilities for application of overhead hoods exist in the jobbing foundries. Fig. 4 shows such a modification that still retains much of the complete enclosure benefits and yet allows handling of flasks with an overhead crane.



Carnegie Illinois Steel Co., Johnstown, Pa.

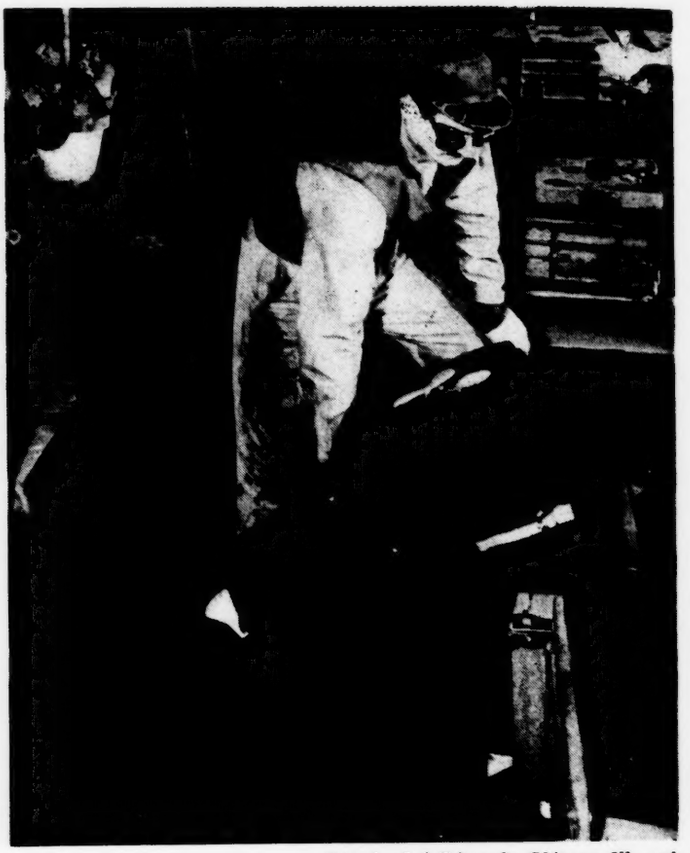
Fig. 8. Shakeouts wider than 8 ft should be provided with side shields as shown.

In new foundry layouts where smaller parts are cast, the castings are often dropped from the vibrating shakeout deck, Fig. 5, to gathering conveyors located below the foundry floor, eliminating the spilled burnt sand, the heat, and the smoke from the shakeout area.

Side Hoods

Where large flasks are involved, the overhead crane will usually be the only answer to transport the flask to the shakeout, and for removal of flask and casting. The side hood, Fig. 6, has demonstrated that reasonably good control can be obtained and that hood construction can be provided that will withstand the rough usage from swinging flasks, crane slings and hook. The mechanical upsetting device illustrated in Fig. 6 justifies duplication in other foundries.

The problem of control is clearly demonstrated in the model hood study, Fig. 7. Large exhaust volumes are required, and cross drafts through the foundry can seriously interfere with expected performance. Volumes in the order of 400 to 600 cfm per sq ft of shakeout grate give good control under most conditions for shakeouts extending not more than 8 ft in the direction normal to the side hood location. For wider units, side shields, Fig. 8, are about mandatory to prevent short circuiting of the air and disruption of the air flow picture by cross drafts.



Woodruff & Edwards, Chicago, Ill., and Chain Belt Co., Milwaukee, Wis.

Fig. 9. Downdraft three-floor dump grilles have proven practical, although downdraft dust control for vibrating shakeouts are seldom successful.

Downdraft

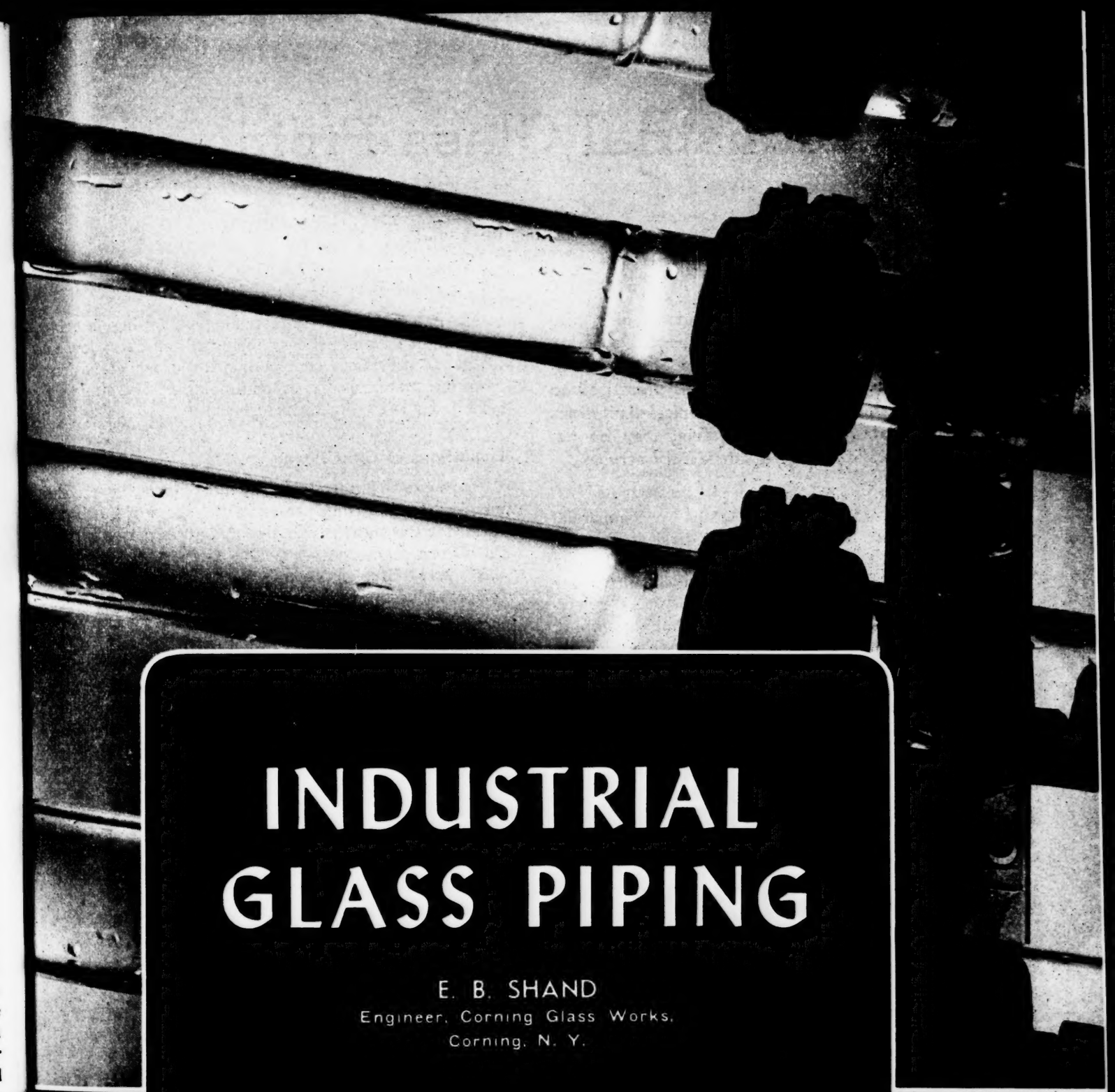
Control of dust from the vibrating shakeout by downdraft control has seldom proved practical or effective and consideration of such systems is discouraged. However, a connection to the shakeout hopper, venting some 10% of total volume exhausted by side or overhead hood, will be useful in preventing rebound as the shakeout sand falls into the shakeout hopper. Such a vent connection will prevent boiling of dust into the shakeout tunnel, or up through the floor openings in the shakeout area. Downdraft has proved practical for the floor dump type of operations, Fig. 9, where sand and castings are dropped from roller conveyor to a gathering conveyor below the floor level. Mechanization of this operation is also practical where molds are upset mechanically and bottom boards returned to the molding stations.

Avoiding Dampness in Basements

Precautions against dampness in the basement should be taken at the time the house is being built, according to an article, "Prevention of Dampness in Basements," published in Technical Bulletin No. 14 by the Housing and Home Finance Agency. Proper steps taken at that time may save large expenditures later when the house is completed and occupied.

The kind of soil and type of construction, together with conditions of exposure, will usually indicate the treatment which should be applied to prevent dampness. However, it is advisable to consult code authorities or other persons familiar with local conditions as to specific measures for prevention or correction.

Principal precautions against dampness include selection of site, surface drainage, sub-grade drainage, water-resistant construction, and insulation.



INDUSTRIAL GLASS PIPING

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A HEATING AND VENTILATING Reference Section

Industrial Glass Piping

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Increasing industrial use is being made of glass piping, for it is capable of resisting the corrosive action of many fluids and it makes possible better sanitation of pipe lines. Basic information is presented to show how, in spite of natural mechanical limitations of this material, glass piping systems may be designed and installed to give satisfactory service.

INDUSTRIAL glass piping became a commercial product about 20 years ago. At first it was regarded with some suspicion so that its use was largely limited to the handling of corrosive chemicals for which no other material was satisfactory. As experience was gained, and as it was found that this piping would meet the requirements of industrial service, its use has been greatly expanded, particularly during and after World War II when a number of large and important installations were made. In one plant alone, 7½ miles of glass piping were installed (1)*.

Industrial glass piping is a natural outgrowth of older and well established uses of glass. In chemical laboratories, glass has been the accepted material for beakers, flasks and tubing. The characteristics which dictate the choice of glass in these applications apply equally well to the handling of fluids in industrial processes. Glass for industrial piping has its advantages and also its limitations.

Advantages of Glass Piping

Corrosion Resistance—Glasses of high chemical durability are suitable for handling a wide variety of corrosive fluids, including all acids except hydrofluoric. They are also resistant to alkaline solutions except in higher alkali concentrations and at elevated temperatures. The substitution of glass for other materials has sometimes eliminated the necessity for frequent periodic replacements of pipe lines. Glass will not contaminate fluids which are in contact with it.

Sanitation—Glass has a smooth, hard surface, which has poor adhesion characteristics for most materials. Glass can be readily cleaned and sterilized, and surface deposits either do not build up, or are readily removed.

Operating Temperatures—It can be operated over a wide range of temperatures, from below 0F to 250F, and higher in special cases.

Transparency—The ability to see the operation of the fluid in the pipe is at times a requirement. In nearly all installations, this is found to be a source of great convenience. For applications involving sanitary requirements, the visual demonstration of the cleanliness of the inside of the pipe is often essential to the conditions of operation.

Other Advantages—Industrial glass piping is relatively light in weight, easy to install, and also low in installed cost when compared with other corrosion-resisting materials. It is obtainable in six standard sizes from 1- to 6-inch, inclusive.

Limitations of Glass Piping

Pressures—Glass piping is not generally recommended for operating pressures in excess of 50 lb per sq in. for the smaller size pipe and 20 lb per sq in. for the 6-inch size.

Stresses—Stresses from any cause must be limited to low values. These include not only stresses from internal pressure, but from various kinds of externally applied loads.

Care in Handling—Glass must be handled with more care than is required for metals. Rough handling may injure the glass or even break it.

Mechanical Failure—If a failure of the line does occur, the break is frequently complete so that the pipe line will discharge at the point of failure.

Properties of Glass

Commercial glasses are available in a variety of compositions, with corresponding differences in their properties. The distinguishing properties which determine the choice of compositions which will meet the requirements of industrial glass piping are as follows:

Corrosion resistance against a wide variety of chemicals.
Low coefficient of expansion with temperature.
Transparency (not all glasses are transparent).

Certain borosilicate glasses, those containing boric oxide, meet these requirements most satisfactorily. Glass No. 7740 (an identifying number of Corning Glass Works), from which Pyrex industrial glass piping is made, is particularly adapted for this purpose. Its composition is approximately: SiO_2, 81%; B_2O_3, 13%; Na_2O and K_2O, 4%; remainder chiefly Al_2O_3. The more important physical properties of this glass are given in Table 1.

Viscosity—Glasses do not have definite melting temperatures, but they become gradually lower in viscosity, that is, more fluid, as their temperature is increased. Glass technologists employ three reference temperatures corresponding to specific values of viscosity as a means of identifying this property. The *softening point* is defined as the temperature at which glass will deform under its own weight at a definite rate. The *annealing point* is the temperature at which glass will anneal under specified conditions. The *strain point* is the lowest temperature at which viscous flow

*Numbers in parentheses refer to bibliography at end of article.

is appreciable. Below this temperature, glass is essentially a solid body. Glass No. 7740 has a higher viscosity than common glasses, so that it will withstand higher operating temperatures without softening or deforming.

Coefficient of Expansion—This property is of importance because it is one of the factors which determine the magnitude of the stresses set up by temperature differentials within the body of the glass. This coefficient for glass No. 7740 is 18 $\times$ 10^{-7} per F, compared with 45 to 50 $\times$ 10^{-7} per F for soda-lime and lead silicate glasses. This means that the thermal stresses set up in this glass are only 35 to 40% as great as in the higher expansion glass, which permits it to be operated under much more severe temperature conditions.

Mechanical Properties—Glasses have certain mechanical properties which differ materially from those ordinarily associated with metals. Because these properties have a distinct bearing on the design, installation and operation of glass piping, they will be discussed briefly.

When metals are stressed in tension, plastic flow takes place beyond the yield point. Complete rupture may not occur until the stress applied is considerably in excess of the yield stress. If the stress distribution was not originally uniform, the metal first yields locally at points of stress concentration, so that in ductile materials there is a strong tendency towards stress equalization long before rupture occurs. This characteristic reduces greatly the "notch sensitivity" of metals so that the ultimate strength is not ordinarily affected by surface scratches, machining marks, and other imperfections. These remarks on metals do not apply necessarily to conditions of cyclic loading which induce fatigue.

Glass, on the other hand, has no yield point, but fracture occurs within the limit of elastic deformation. This renders glass highly notch-sensitive, and makes the measured strength dependent upon the magnitude of some critical stress concentration present. It also causes glass to fail from a direct tensile stress rather than in shear as is the case for ductile bodies, so that the material is generally found to be relatively weak in tension, but strong in compression.

These unusual properties also render glass more vulnerable to injury than metals. A sharp blow delivered on a metal surface will probably produce a slight indentation—evidence of plastic flow at the point of impact—which will have no appreciable effect upon strength. A similar blow delivered against a glass surface will not cause an indentation of this kind. The surface will be bruised, and tiny cracks will be found around the point of impact. These cracks or "checks" are found to cause high stress concentration factors which, consequently, may have a pronounced effect on the measured strength of the glass. Failure is ordinarily associated with such surface conditions. The rubbing of one piece of glass against another also tends to impair the surfaces, although usually to a much less degree.

Another characteristic which is found to be more pronounced in glass than in metals, is the effect of long-time loading in reducing the breaking strength.

TABLE 1—PHYSICAL PROPERTIES, GLASS No. 7740

Softening point	1,510F
Annealing point	1,030F
Strain point	960F
Maximum operating temperature	
Annealed	950F
Tempered	530F
Thermal conductivity	
75F	8.1 Btu per hr (sq ft) (F/inch thickness)
400F	add 20%
Mean specific heat	0.2 Btu per lb per F
Modulus of elasticity	9.8 $\times$ 10^6 lb per sq in.
Poisson's ratio	0.22
Coefficient of linear expansion	18 $\times$ 10^{-7} per F
Density—specific gravity	2.23

For annealed glass, the stress which may be sustained for an indefinite period may be less than 50% of the stress required to break it within a period of one or two seconds. For tempered glass, this corresponding ratio may be as high as 80%.

The strength of glass can be raised materially by a heat-treatment known as tempering. In this operation, permanent residual stresses are set up in the body of the glass which are compressive in the critical surface layers, and so tend to neutralize any tensile component in these layers resulting from externally applied loads. The permissible working stresses in a piece of tempered glass may be increased from two to four times those in the corresponding piece of annealed glass.

Tempering has recently been applied to glass pipe fittings such as elbows and tees, where the geometrical shape of the piece causes the stresses to be much higher than in straight lengths of pipe. The flanged ends of straight lengths are also tempered to permit them to resist the additional stress components which are produced by the clamping forces of the metal flanges.

Effect of Temperature on Strength

Annealed glass retains its strength properties and will not deform sensibly at temperatures which approach closely the strain point of the glass. It can be used at such temperatures if the entire glass body is relatively close to the same temperature, so that no serious thermal stresses are produced. Tempered glass, on the other hand, should not be used at temperatures within 400F of the strain point, otherwise the effects of tempering may become impaired with time (2).

Ordinarily, the maximum allowable operating temperature of glass piping is determined by the stresses which result from the temperature difference between the inner and outer surfaces of the pipe. Under conditions of equilibrium these stresses are proportional to this temperature difference, and also to the coefficient of expansion of the glass. When one surface is suddenly heated or chilled, the stresses are momentarily higher, and they are a function of the thickness of the glass as well. These transient stresses are often referred to as thermal shock.

A relative measure of the resistance of glass articles to thermal shock can be determined by heating the article in an oven and then plunging it in water. The

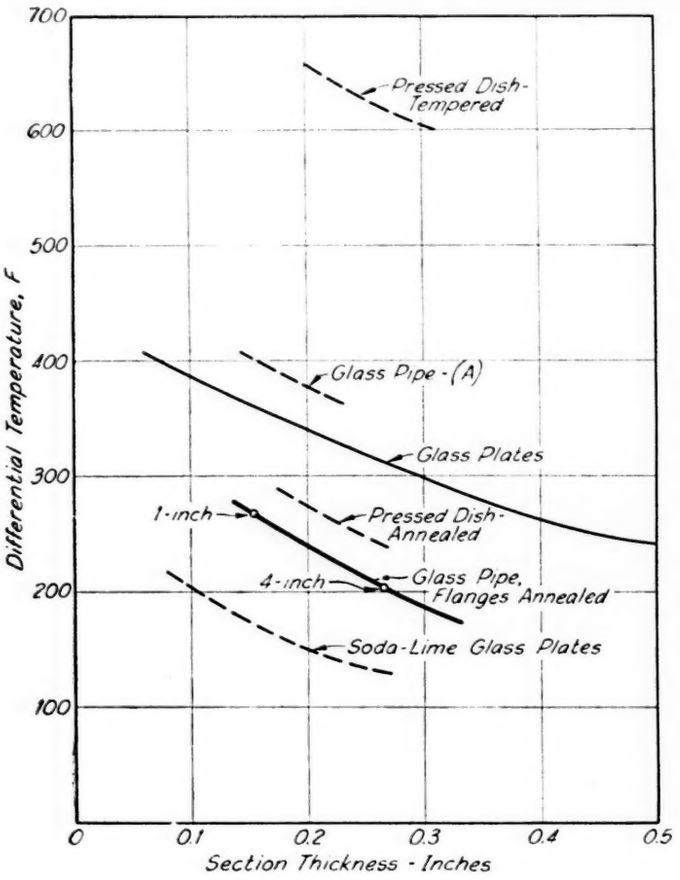

Fig. 1. Thermal shock resistance of glass.

difference between the temperature of the heated glass and that of the water when breakage occurs is an indication of this resistance. Fig. 1 represents data of this sort. All values given refer to glass No. 7740, except one curve which is for soda-lime glass which may be compared with the corresponding curve for glass No. 7740. The coefficients of expansion of the two glasses are, respectively, 45 $\times$ 10^{-7} per F and 18 $\times$ 10^{-7} per F. It will be noted that the thermal shock resistance of the Pyrex pipe with annealed flanges is lower than that of plates of the same thickness. This results from the higher stresses produced in the conical flanges at the two ends of the pipe. The range of values shown as "2-inch Pyrex pipe—(A)" were measured under a different test procedure. A closed section of pipe was heated in an oven, after which tap water was admitted through an inlet at one end. This condition represents more nearly the conditions of thermal shock which might be met with in service.

Service experience has shown that when the fluid in glass pipe is at a temperature of 250F, with an ambient air temperature on the outside of 50F, the resulting stresses are not excessive. This differential temperature of 200F may be applied to sizes up to 3-inch, inclusive. For 4-inch pipe, this value should be reduced to 175F, and for 6-inch pipe, to 160F.

It is common practice in the case of food and milk lines to sterilize them with low pressure steam, before or after flushing them with tap water.

When the pipe line is covered with some type of thermal insulation, the temperature drop from the inner to the outer surface of the glass may be reduced materially, and with it the resulting stresses. Such insulated lines can be operated at materially higher temperatures than uninsulated lines.

Corrosion Resistance*

Although commercial glasses generally have good corrosion resistance properties, there are marked differences in this property between glasses of different compositions. Some of the borosilicate glasses, and in particular glass No. 7740, are outstanding in their durability against the action of a wide range of chemical reagents. Certain glass compositions are available which are more resistant to specific groups of chemicals, but these glasses have other limitations which render them unsuitable for general application to industrial piping. For instance, several types of glass compositions have a somewhat higher resistance against alkaline solutions, but have higher coefficients of thermal expansion—usually much higher—which reduces their resistance against thermal stresses.

Extensive experimental studies of the corrosion rates of glasses have shown a number of peculiarities in the results obtained, indicating that the phenomena involved are of a complex nature. Slight variations in the conditions of test may affect the results materially,

*The assistance of Dr. M. E. Nordberg, Corning Research Laboratory, is acknowledged in the preparation of this section on Corrosion Resistance.

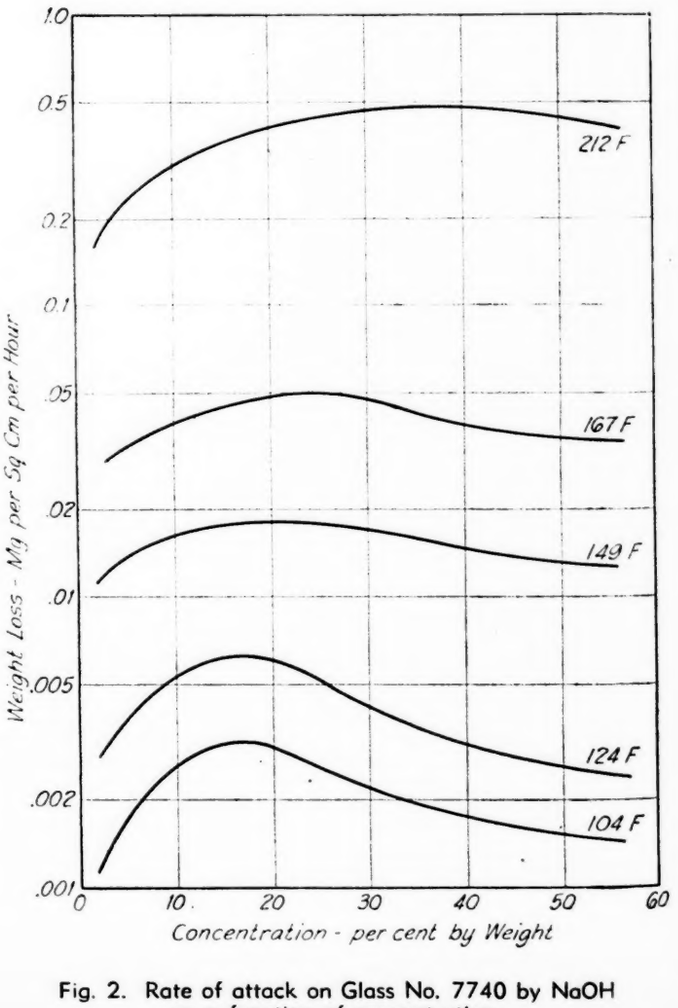

Fig. 2. Rate of attack on Glass No. 7740 by NaOH as a function of concentration.

even for the same reagent and the same temperature. Except for the cases of hydrofluoric acid and strong alkaline solutions, the attack does not increase as a linear function with time, but the rate of attack tends to fall off definitely with time. For solutions of NaOH, KOH and NH_4OH, it is found that the rate of attack does not increase indefinitely with concentration, but rises to a maximum, and then decreases. Results for NaOH, at various temperatures, are shown in Fig. 2.

The corrosion resisting properties of glasses are closely related to those of silica, their principal constituent, although important modifications may result from the presence of other constituents. Alkali constituents of glasses will ordinarily be leached from the silica structure at a faster rate than the silica itself is attacked.

If the leaching effect predominates, the exposed surface of the glass is left in a porous state, high in silica content. This will introduce a diffusion process which tends to decrease the rate of reaction with time. When the rate of attack on the silica is comparable with the rate of leaching of other constituents, the whole process becomes roughly linear with time. In considering the use of glass piping for alkaline solutions, both the alkalinity and the temperature must be taken into account.

As a rough rule, the rate of attack will increase by a factor of 3 for each unit increase in the pH of the solution. For temperature, the rate of attack tends to double for each increase of 15 to 20F, as indicated in Fig. 3.

TABLE 2—CHEMICAL CORROSION RATES—GLASS No. 7740

Reagent	Temp, F	Time, Hours	Weight Loss, Mg per Sq Cm	Inches, Thickness Lost per Year
5% NaOH	212	6	1.4	.36
N/50 Na_2CO_3	212	6	.12	.031
5% HCl	212	24	.0045	.0003
3% NH_4OH*	176	100	.33	.0051
85% H_3PO_4	212	24	.009 to 0.19	.0006 to .0010
H_2O	212	6	.0005	.00013 to .00021
		48	.0066	
5% Sea salt	212	24	.03 to .08	.002 to .005
20% Sea salt	104	100	.025	.0004

*Maximum corrosion rate for this temperature occurs for concentrations between 0.5 and 3.0%.

In Table 2 are the results of laboratory tests on the chemical durability of glass No. 7740 as taken on specimens immersed in a number of different chemicals. Unless otherwise noted the glass referred to in figures and charts is glass No. 7740.

Results in Table 2 are expressed in terms of the milligrams weight lost per square centimeter of exposed surface for the period of the test. For purposes of convenience and comparison, these values have also been converted to the corresponding inches of thickness lost per year, although this extrapolation is not valid for all reagents, because the rate of attack may diminish materially with time.

Table 3 summarizes the corrosion resisting properties of glass in general terms. Glass piping has been found to give excellent service in conveying such materials as hot concentrated acids, such as H_2SO_4, HCl and HNO_3, wet chloride gas at elevated temperatures, corrosive plating solutions, and many chlorinated compounds. Certain very corrosive solutions such as inorganic acids combined with chlorinated hydrocarbons or solvents, or with further additions of metallic salts, have also been handled very satisfactorily.

Glass piping is not recommended for hydrofluoric acid, concentrated alkaline solutions at elevated temperatures, or for phosphoric acid containing even small amounts of fluorides, although pure phosphoric acid will not attack this glass seriously until relatively high temperatures are reached, as indicated in Table 2.

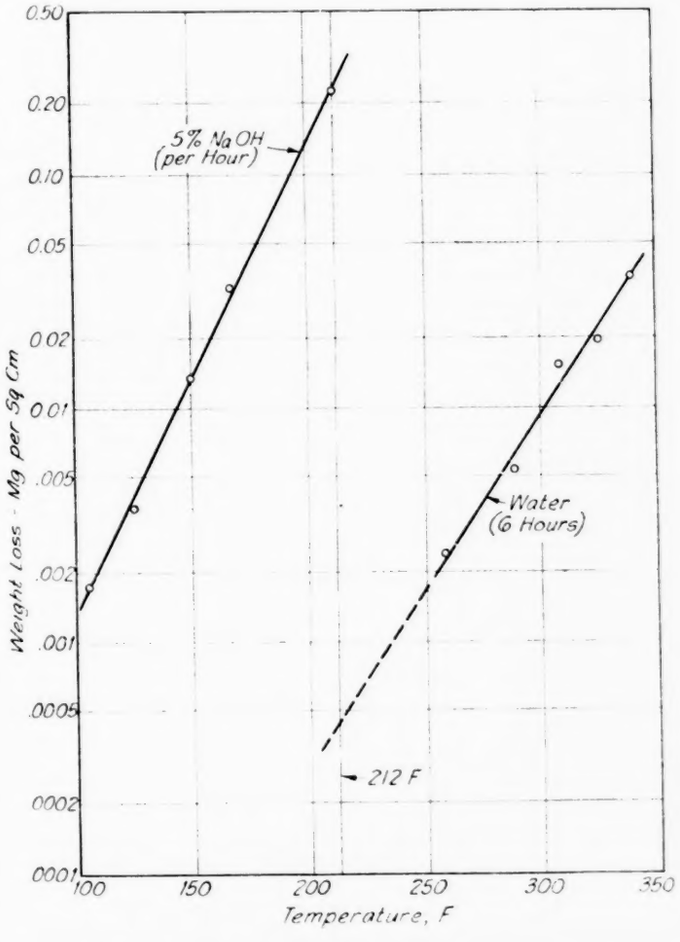

Fig. 3. Rate of attack on Glass No. 7740.

Biological Properties

Glass pipe is not affected by insects, molds, fungi or bacteria. Glass surfaces are hard and smooth, so that they are readily cleaned and sterilized. As a consequence, glass piping is particularly suitable for use with pharmaceutical and food products.

Contamination

Chemical attack may result in contamination of the active reagent which may affect its quality adversely. When glass piping is used, not only are the products of chemical attack very minute, but the compounds re-

TABLE 3—CHEMICAL CORROSION, INDUSTRIAL GLASS PIPE

Type of Reagent		Temp, F	Attack	Remarks
WATER		Room	Inert	Glass is completely non-absorbent and non-swelling.
		212	See Table 2	
Sea water (5% sea salt)		Boiling	See Table 2	Glass immersed in ocean 1 yr—no visible effect.
ACIDS	HF	All	Severe attack	Not recommended.
	85% H_3PO_4	212	See Table 2	Satisfactory for applications except at higher temps. Not recommended if acid contains fluorides.
	Other inorganic	All*	Inert	For 5% HCl at 212F, see Table 2.
	Organic	All	Inert	
BASES	Strong	212	5% NaOH—see Table 2	Recommended at lower temperatures.
	Weak	176	3% NH_4OH—see Table 2	Attack relatively lower. Recommended.
HALOGENS		All	Inert	Exception—dry fluorine, questionable.
METAL SALTS	Acid	All	Inert	
	Neutral	All	Inert	
	Basic	212	N/50 Na_2CO_3—see Table 2	Recommended—Attack occurs at higher concentration and temperatures.
INORG. NON-METAL. HALIDES		All	Inert	Exception—fluorides.
Sulphur dioxide		All	Inert	Slight bloom may appear on surfaces.
Ammonia (dry)		All	Inert	For ammonium hydroxide, see bases.
Oxidizing chemicals		All	Inert	
Reducing chemicals		All	Inert	
Hydrocarbons		All	Inert	Recommended for chlorinated hydrocarbons.
Amines		All	Inert	Possible exception—Amines with pronounced basic reaction.
POLYHYDROXY ALIPHATICS		All	Inert	
Mercaptans		All	Inert	
Oils and Fats		All	Inert	

*"All" refers to normal maximum operating temperature of Pyrex piping, 250F. Table is adapted from *Industrial and Engineering Chemistry*, October, 1948.

sulting from chemical reaction are ordinarily less harmful than in the case of other materials.

Industrial Glass Piping

Pyrex piping is made in six sizes from one to six inches internal diameter. Standard sections are available for all sizes up to 10 ft in length. Information on sizes, dimensions, tolerances, and weights per foot is given in Table 4. For sizes shown, length tolerance is ± 1/32 inch. Common fittings such as elbows, tees, crosses, laterals, U-bends and reducers are also available.

Close dimensional tolerances are important, for the sections are ordinarily prefabricated and must fit in the allotted space. These same tolerances also apply to all standard fittings, that is, ± 1/32 inch on leg lengths and over-all lengths, and ½ deg for the angles between flange faces.

Joints

Conical Flanged Joints — This consists of an enlarged conical flange on the ends of all straight sections and on the open ends of all fittings. An interface gasket of sheet material is placed between the two mating flange faces at the joint and the longitudinal pressure required to seal this gasket is applied by two metal flanges, one on each end, which fit against the conical glass flanges, but are separated from them by sheet asbestos inserts. Bolts are used to provide the pressure. The general arrangement of these conical joints is shown in Fig. 4. The metal flanges are available in either cast iron or cast aluminum, with bolts and nuts correspondingly of cold rolled steel and aluminum.

The interface gaskets may be of any of a number of nonmetallic materials, depending upon the requirements of the fluid in the pipe and its temperature. The gaskets are cut from ⅛-inch sheet stock, except in the case of Teflon which may be molded. Added information on gasket materials commonly used and their application will be found in Table 7.

Beaded Flange—Under some conditions where prefabricated straight sections of pipe with conical flanges are not readily available, particularly in special lengths, sections with a beaded flange can be fabricated by the user in his own plant. Simple equipment can be used for cutting plain pipe to the proper length and then forming a beaded flange on the cut end. This type of joint can be used on pipe up to and including 3-inch.

For the joint assembly, the same metal flanges and bolts are used as for the conical joint. In addition, plastic follower rings and molded rubber gaskets are used in place of the asbestos inserts. Fig. 5 shows the details of a beaded joint. A joint

TABLE 4—INDUSTRIAL GLASS PIPING—STRAIGHT SECTIONS

I. D., Inch	O. D., Inch	Mean Wall Thick., Inch	Length—Inches		Lb per Ft, Avg.
			Min.	Max.	
1	1 5/16	5/32	3	120	0.55
1½	1 27/32	11/64	3½	120	0.87
2	2 11/32	11/64	4	120	1.13
3	3 13/32	13/64	5	120	1.97
4	4 1/2	17/64	8	120	3.41
6	6 9/16	21/64	9	120	6.10

can be made consisting of a conical flange on one pipe section and a mating flange of the beaded type. The standard interface gaskets for the conical flange joint can also be used in the beaded joint, particularly for the softer gasket materials.

Special Joints—Connections must sometimes be made between glass pipe and piping or flanged connections of other material. Flanges and adaptors can be obtained for connecting this piping to threaded or flanged steel piping, sanitary stainless steel piping, and glass lined piping or flanges.

Special Glass Fittings

Special fittings and other parts can be fabricated when required. Long radius bends, special angle elbows or laterals, manifolds and many other shapes can be made. These fittings will not ordinarily meet the dimensional tolerances of standard fittings, which are fabricated in jigs, and they will not be tempered.

Joint and Gasket Design

The conical flanged joint for glass pipe was designed with special consideration of the mechanical properties of glass, namely—high compressive strength, but limited tensile strength. The axial force of the clamping bolts is transmitted to the gasket by the compressive forces acting between the metal and glass conical surfaces. The angle of the cone is such that the total radial compressive force acting on the conical surface is much greater than the axial force producing it. As long as the resulting stresses in the glass are purely compressive, failure will not occur.

Tensile components of stress cannot be eliminated completely. The forces of radial compression acting on the glass flange produce deflections in a radial direction and consequently bending moments in the wall of the pipe and thus tensile stresses in local areas (3). Any variation from true roundness in either the glass cone or the inner surface of the metal flange produce circumferential bending stresses in the glass. If the two mating flanges are not in close angular alignment, the bolting forces tend to bend the entire pipe as a beam. All of these stresses build up to a maximum in the vicinity of the conical flange and tend to increase with the bolting forces.

To minimize these stresses, the conical flange is pressed as a separate piece of glass, which permits heavier sections through the flange and greater accuracy in the roundness of the conical surface. This end piece is then joined to the plain pipe by a method of fusion sealing. The width of the face of the flange in contact with the gasket is made relatively narrow in order to reduce the magnitude of the bolting forces

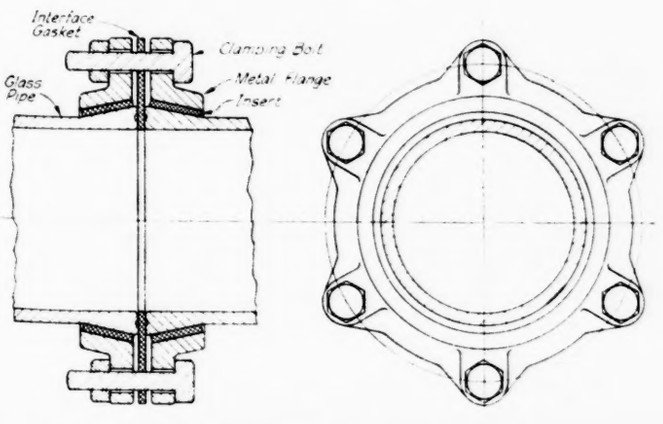

Fig. 4. Conical flange joint for industrial glass piping.

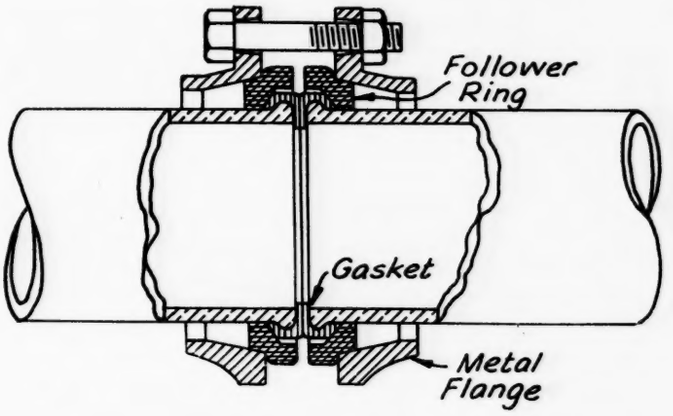

Fig. 5. Beaded pipe connection for 1- or 1½-inch pipe.

required. The total section area of the clamping bolts is held down to a value which will permit the bolt material to yield before failure will occur in the glass.

When conical flanges were annealed, it was shown by tests that this last condition could not always be met, and that breakage of the glass sometimes occurred before either the bolts or flanges failed. Analysis of available records of failures also showed that there was a high incidence of failures located in the flanges of straight sections and in the fittings. Steps were then taken to completely temper all standard fittings, and also to temper the ends of all straight sections. This improvement has been effective in raising materially the strength level of this piping as a whole.

Pressures which must be exerted on the gasket in order to prevent leakage at the joint depend upon the compressibility characteristics of the material used for the interface gasket, and also to some extent upon its thickness. Gasket materials exhibit combined properties of elastic compressibility and permanent deformation in varying degrees. The permanent deformation is also a function of time under load. The effective width of the gasket is a factor in determining the amount of compression because of the tendency for side flow of the material.

Results obtained on two grades of bonded asbestos gaskets after being clamped in the joint of a 2-inch pipe are shown in Fig. 6. The curves show the maximum depth of the permanent indentations in the gasket after 24 hours, and also the relaxation of the bolt forces for this same period. This decrease in bolt force results not only from the permanent deformation of the interface gaskets, but also to a smaller degree from the permanent set of the inserts placed between the metal flanges and the glass surfaces. These curves show that all flange bolts should be retightened from time to time after a line or a gasket in a joint is first installed.

From tests on pipe joints, it has been found that it is necessary to exert a certain minimum specific pressure on a gasket to make it conform to the flange faces

TABLE 5—SURFACE PRESSURES ON GASKETS

Interface Gasket Material, ⅛ Inch Thick	Surface Pressure on Gasket for Sealing, Lb per Sq In.
Soft rubber	< 350
Rubber or Neoprene (Durometer 65)	350 to 400
Asbestos (bonded)	700 to 900
Teflon sheet over rubber	1,000
Teflon, solid sheet	1,600

to prevent leakage even at low fluid pressures. From this minimum, only moderate increases of gasket pressure are necessary to insure tightness of the joint under fluid pressures considerably in excess of the recommended pressure limits of the piping.

In actual service, small amounts of flexure will occur at the joints of this glass piping, so that the gasket pressures must be sufficient to take care of this condition. From the results of other tests, in which the pipe joints were subjected to flexure, the average pressures per square inch of gasket surface to insure tight joints in service are given in Table 5.

Knowing the effective area of the faces of the flanges for the various sizes of pipe, and using the information of Table 5, the torque requirements for the clamping bolts can be determined. To express the relationship between nut torque and bolt pull, the following Kingsbury formula is entirely adequate for the present purpose and is simple to use:

$$\text{Bolt pull (lb)} = \frac{\text{Torque (lb in.)} \times 5}{\text{Nominal bolt dia (in.)}}$$

Based on such calculations and also on service experience, the torques applied to the clamping nuts at the flanges in Table 6 are recommended. These torque values should be sufficient to prevent seepage at the joints after the gaskets have become set. If not, the recommended torque values of Table 6 may be increased moderately.

In tightening the clamping bolts during installation or for maintenance, it is frequently inconvenient to employ a torque wrench to meet these or other torque values selected. However, a common open-ended wrench can be used satisfactorily if the user will check his individual pull, using the same wrench against a torque wrench before attempting to tighten the nuts, and at intervals during installation operations. Experience has shown that a good workman can control his wrench pull satisfactorily for one or two days without rechecking.

It has also been found that, unless some system is used to control the bolt torques, there is a strong tendency for excessive bolt forces to be used. Experience obtained from pipe lines in service has shown that such forces have caused failure of the glass in the conical flanges when annealed, and tearing of the softer types of interface gaskets.

Choice of material for use as an interface gasket depends upon the fluid handled in the pipe line and also its temperature. A wide range of applications can be handled by a relatively few types of materials, as indicated in Table 7. For food products, contamination of the product is an important factor. For chemicals, resistance against disintegration and against swelling are important. For high temperatures, bonded asbestos sheet, and Teflon, either in the form of rolled sheet or in molded rings, have proved to be most satisfactory. Experience with Teflon is still somewhat limited. Its maximum operating temperature appears to be limited mainly by plastic flow, which may become excessive at higher temperatures.

TABLE 6—BOLTING TORQUES, PYREX PIPE JOINTS

I. D. Pipe, Inches	Bolts		Recommended Nut Torque, Lb-Ft			Nut Torque for 25,000 Lb per Sq In., Root-of-Thread, Lb-Ft
			Conical Flanged Joint		Beaded Joint*	
	Size, Inch	No.	Normal	Solid Teflon	Normal	
1	5/16	3	2	2 to 3	2	5½
1½	5/16	3	3 to 3½	3 to 4	2½ to 3	5½
2	5/16	3	3 to 4	4 to 5	3 to 3½	5½
3	5/16	6	3 to 4	4 to 5	3 to 3½	5½
4	1/4	6	3 to 4	5 to 6	.....	2¾
6	3/8	8	5 to 6	7 to 9	.....	10

*These torque values for the beaded joint are applicable only to the softer gasket materials.

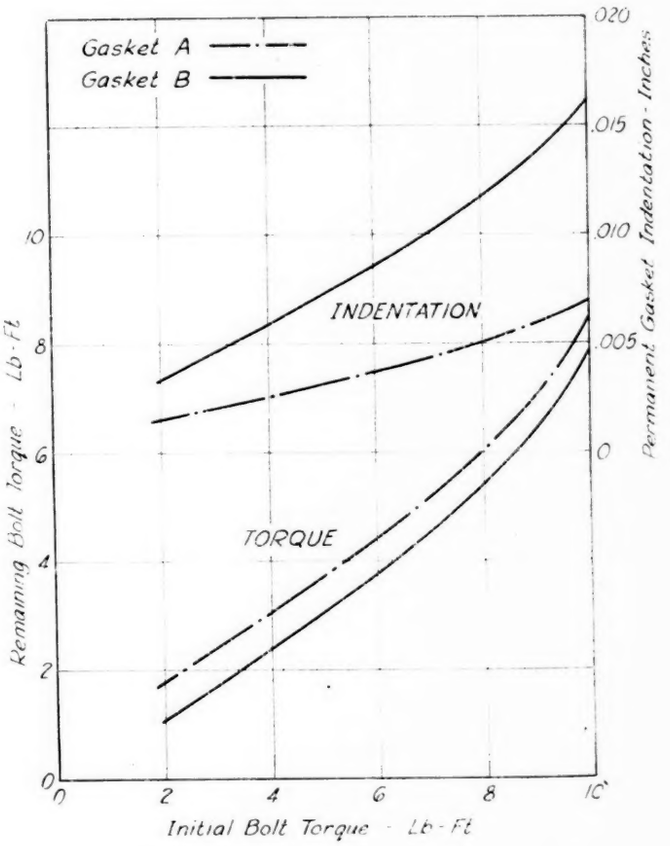

Fig. 6. Effect of 24-hour clamping on 2-inch pipe joint on two grades of bonded asbestos interface gaskets.

Working Stresses and Flexibility

To obtain the maximum degree of reliability and lowest maintenance costs, the stresses to which glass piping is subjected in service must be limited to conservative values. The maximum sustained tensile stress should not exceed approximately 1000 lb per sq in. For the 4- and the 6-inch sizes this value should be appreciably lower. These stress values apply only to the straight lengths of piping exclusive of the conical ends, because these are tempered to permit them to withstand the excess stresses set up by the clamps, as already mentioned. This applies to the tempered fittings as well.

Various forces act on a section of pipe in a line which set up corresponding stress components in the pipe. The more important stresses to be considered are:

(1) Those resulting from the internal pressure of the fluid.
   (a) Tangential or hoop stress in the pipe wall.
   (b) Axial or longitudinal stress in the pipe wall.

(2) Bending stresses caused by forces applied to bring the flange faces into alignment during installation, or from relative shifts between the pipe line and supporting structures during operation, as a result of temperature changes, restraint of hangers and clamps.

(3) Tensile stresses resulting from inexact length fit of pipe sections during installation, or relative shifts in operation.

(4) Bending and shear stresses resulting from the weight of the pipe and fluid between supports.

(5) Miscellaneous stresses which may be superimposed on the other stresses, and which may result from water-hammer, vibration, surging and inertia forces caused by the closing of a valve.

These separate components may combine to produce a stress at some point in the pipe which is greater than any single component so that no single component should exceed 30% to 40% of the allowable maximum stress permissible. Table 8 gives the recommended pressures for the various sizes of pipe, the corresponding stresses, and also the maximum recommended bending stress. It may be noted that the axial pressure stress and the bending stress will combine directly at some point in the pipe wall. There are numerous lines now giving satisfactory service where these recommendations have been exceeded to a considerable degree, but for assured reliability, the more conservative limits are justified.

Stresses set up in the piping during installation, and those resulting from relative movements between piping and structures are closely related to each other. In the case of metal lines, it is common practice to keep such stresses within allowable limits by providing for flexibility in the layout and in the support of the line. For glass pipe lines, this condition is at least equally important because of the low values of stresses permitted. The principle of pipe flexibilty is based largely on the ability of the pipe to deflect in bending, so that where length adjustment is required in a run, at least one pipe section will be laid out at right angles to the main run. For instance, if a 100-ft straight run of 3-inch pipe were made without joints, the permissible length increase without exceeding a stress of 500 lb per sq in. in the glass would be approximately 0.06 inch. If, however, a 10-ft section is added at right angles to the main run, and joined with standard elbows, the corresponding length adjustment

TABLE 8—RECOMMENDED PRESSURES AND STRESSES FOR GLASS PIPE

I. D. Pipe Size, Inch	Wall Thickness, Inch	Max. Pressure	Pressure Stresses		Bending	
			Hoop	Axial	Moment, Lb-In.	Stress, Lb per Sq In.
		Pounds per Square Inch				
1	0.156	50	160	69	45	300
1½	0.172	50	218	95	105	300
2	0.172	50	290	136	165	275
3	0.203	50	370	164	390	250
4	0.265	35	264	130	780	225
6	0.328	20	183	100	200	1,800

TABLE 7—APPLICATION OF GASKET MATERIALS

Material Handled in Pipe	Test Temp, F	Maximum Operating Temperatures, F					
		400	220	275	150	220	400
		Recommended Use of Gasket Materials					
		Asbestos Bonded	Rubber, Sulfur-free	Neo-prene-Cork	Koroseal	Teflon-Sheathed Rubber	Teflon Sheet
Food Products Milk, Wine Distilled Water		X	A	A	X	A	A
Hot, Wet Cl_2		A	X	X	X	A	A
20% HCl	228	X	A	B—	A	A	A
50% H_2SO_4	257	B to B—	A	A	A	A	A
50% HNO_3	248	X	X	X	A—	A	A
Glac. H Ac	245	A	B	X	A	A	A
Monochloro-benzene + 5% HCl	270	B to B—	X	X	X	A	A
Benzene	176	A	X	X	X	A	A
Acetone	135	A	A	B+	X	A	A
Mild Alkaline Solutions	212	A to B	A	A	A	A	A

Recommendations: A—excellent; B—satisfactory; X—not recommended. Based on accelerated tests made by boiling the gasket material in the test liquid for 3 hours, and from service experience.

TABLE 9—APPROXIMATE DEFLECTIONS BASED ON BONDED ASBESTOS SHEET GASKETS ⅛ INCH THICK
TABLE TO BE USED WITH FIG. 7

I.D. Pipe, Inch	Deflection—Inch						Side Thrust		
	A	B	C	D	E	F	Stress, Lb per Sq In.	At 5 Ft	At 10 Ft
								Pounds	
1	0.22	0.52	0.82	0.21	0.36	0.72	300	0.75	0.375
1½	0.16	0.36	0.56	0.14	0.24	0.48	300	1.75	0.875
2	0.11	0.26	0.40	0.10	0.17	0.34	275	2.75	1.375
3	0.07	0.14	0.21	0.053	0.09	0.18	250	6.5	3.25
4	0.046	0.11	0.17	0.042	0.072	0.145	225	13.0	6.5
6	0.030	0.07	0.10	0.025	0.042	0.084	200	30.0	15.0

would probably exceed 0.40 inches, or a value 7 times greater.

Part of this adjustment comes from the deflection of the glass pipe, although there is an additional deflection which comes from a small amount of flexure of the conical joint itself. The deflections for various combinations and sizes of glass pipes and fittings, based on the bending stresses given in Table 8, are shown in Fig. 7 and Table 9. These deflections are based on conservative values obtained with bonded asbestos gaskets ⅛ inch thick. For softer gaskets these deflections can be increased somewhat, while for solid Teflon gaskets they should be reduced by approximately one-third.

At certain points in a line, such as connections to flanges on immovable pieces of equipment—tanks, pumps, independently supported valves—the pipe line is fixed with reference to structural supports. These are called anchor points of the line. To retain line flexibility, it is important that there should be no more than one anchor point in any single straight run of piping. Fig. 8 illustrates this principle applied to a simple piping layout.

When a glass line is heated, the differential expansion between the line and the supporting structure is much less than for a corresponding steel line, but the flexibility requirements are even greater because the stresses in the glass must be maintained at much lower values. Table 10 gives some comparisons of temperature expansion values for steel and glass piping.

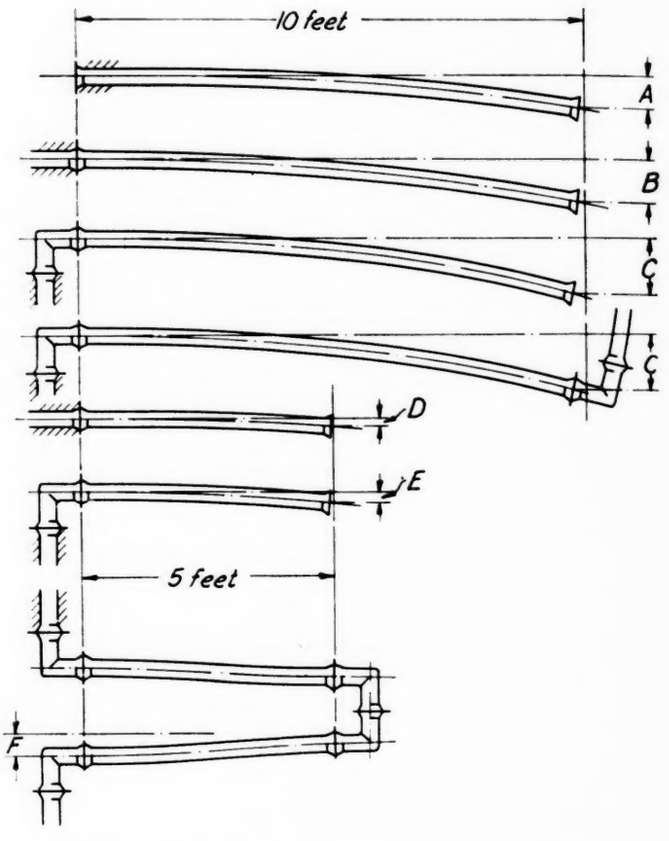

Fig. 7. Limiting lateral deflections for use with Table 9.

Piping Layout and Installation

In preparing a piping layout, use of the line should first be determined, including the rate of flow of the fluid being transferred, approximate static heads and total pressures. From this, pipe sizes and pump capacities can be determined.

TABLE 10—THERMAL EXPANSION OF PIPE LINES

Pipe Material	Temperature Condition, F	Thermal Expansion, Inches per 100 Ft
Steel	70—400	2¾
Steel	70—600	4½
Pyrex	70—212	5/16
Pyrex	70—350	⅝
Pyrex	Both pipe and steel structure going through a temperature change —15F to 90F	⅝

Preliminary Sketch Important

A preliminary sketch can then be made showing the general layout. Except for very simple layouts, an isometric view will probably be most satisfactory. From this preliminary sketch, the approximate requirements of straight lengths, fittings, valves and accessories can be determined. In estimating the straight lengths, allowances should be made for the space taken up by fittings and valves included in the line, and also 3/32 inch for the thickness of the interface gasket at each joint. Whenever practicable, the layout should be made to utilize standard lengths.

These are more readily available than special lengths and their use cuts down the number of spares which are required for maintenance and repairs. Slight changes in the preliminary sketch may be necessary to permit the use of standard lengths. When pipe sections, prefabricated to specific lengths, are connected together into a line, the over-all lengths may not match precisely the dimensions either scaled from a drawing or determined from measurements. In order that these normal adjustments may be taken up readily, it is important that the layout provide adequate flexibility, using right-angled bends in the manner described. Slip joints can also be used for this purpose, but they are not ordinarily recommended. In general, they require more maintenance than the conical flanged joint and, furthermore, the forces required to produce actual slippage of the joint after installation may exert undesirable stresses in the glass.

Glass piping should not be located in areas that are exposed to traffic. It is usually desirable to run them relatively close to building structures, such as walls, columns and ceilings, where conditions are favorable for obtaining a firm support. When very long hanger rods are used, there may be some tendency for the line to sway under the effect of surging or other forces. When it is necessary to run a line through exposed areas, protective measures should be taken. Guards can be made from expanded metal screen or other materials.

Drainage points for the line should be selected and the horizontal lines should be given the proper pitch —at least ½ inch in 10 ft. When a line is to be connected to a bottom outlet of a tank, it is desirable that a valve be interposed between this outlet and the line. In the event of trouble in the line, flow from the tank can be stopped.

The location of anchor points, and their effect on line flexibility, should be given consideration. If the degree of flexibility is inadequate, the layout should be revised to meet this condition. All valves and heavy parts should be supported independently, and not from the glass pipe. They are, therefore, to be considered as anchor points in the line.

Hangers on horizontal runs should be well spaced from elbows leading from fixed vertical runs. If such flexibility is not permitted between the hanger and the elbow, high bending stresses may then result in this section.

The probable temperature adjustments in different runs should be estimated and checked against the permissible deflection as given in Table 9. Fig. 7 should be used with this table.

When laying out pipe lines for foods, particularly milk lines, provision should be made for the recirculation of cleaning and sterilizing solutions. In some cases, this result can be obtained by arranging a short interconnecting run which can be connected temporarily between two separate lines during the cleaning period. Where the layout includes a long single line separated from other lines, it may be desirable to run two smaller lines in parallel for normal operation, but which can be interconnected at the far end with a short section of pipe for cleaning.

When the final layout is complete, bills of material can be made out for the requirements of the line. This should include:

(1) Straight glass sections, including spares.*
(2) Glass pipe fittings, including spares.*

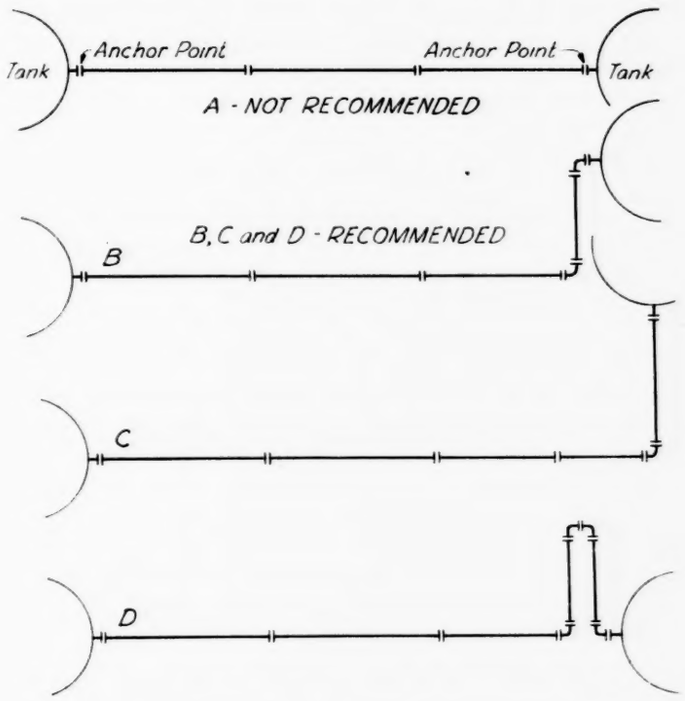

Fig. 8. Straight runs between two opposing fixed flanges.

(3) Accessory parts such as metal flanges, gaskets, adaptor flanges and bolts—specifying the material of the metal flanges and bolts and of the gasket material. Spares should also be included.
(4) Valves, pumps and any other equipment required.
(5) Hangers, brackets and other supports.

Installation

If the work of installation is not begun immediately after receipt of the material, all glass parts should be set aside so that the glass is protected from contact with other glass and metal parts.

The metal flanges and inserts should be assembled on all conical flanges before the pipe is hung. When the joint is assembled, the interface gaskets should be centered on the conical flanges before tightening the clamping bolts, and the nuts, rather than the bolts, should be turned in order to prevent displacement of the gasket.

The assembly of the pipe sections should be started from one of the fixed points, such as a flange on a tank, and one section after another hung, the flange bolts being only partially tightened. Sometimes the piping is hung temporarily, hangers and brackets being installed after connecting together a few sections of piping, to ensure that the hangers are aligned to the pipe rather than forcing the piping into an alignment already established. When carefully and accurately

*For spares of glass parts, it is recommended that one spare be ordered for every 12 pieces of any item. There should be one spare for every item used.

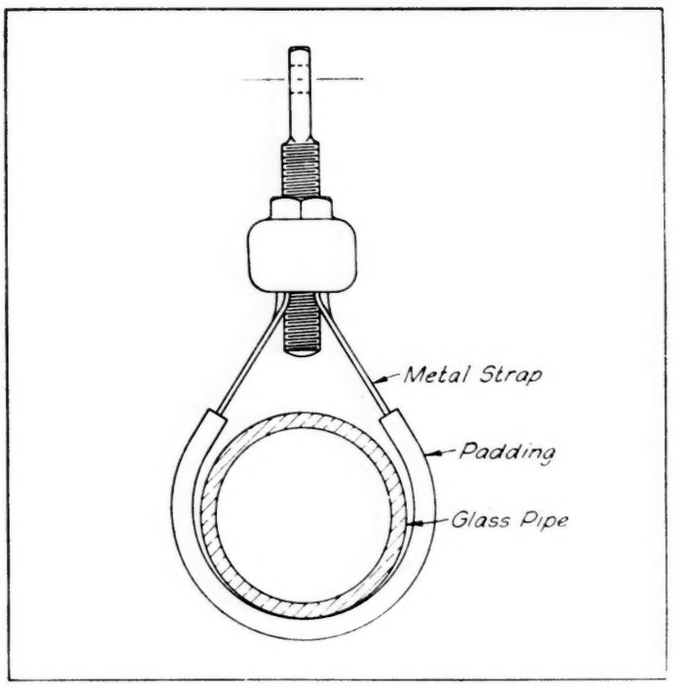

Fig. 9. Hanger for glass pipe.

laid out, it is practicable to install hangers and brackets before connecting up the pipe sections, particularly for a long run. In either case, it is desirable to have all hangers and brackets ready before installation begins.

Flange bolts at the joints should not be given their final tightening to the specified torque until the entire run is all connected, and the hangers and other supports adjusted. Open-end wrenches, 4 or 6 inches long, are convenient for tightening these bolts, but the wrench pull of each workman should be checked against a torque wrench before the bolts are pulled up.

Hangers and Supports

Various types of hangers can be used satisfactorily for glass piping. Those using a metal strap passing loosely under the pipe, Fig. 9, have worked very well. Contact between metal parts and the pipe should be prevented by placing some padding over the metal. For milk and food lines, however, special sanitary hangers are usually preferred. Where the hanger design provides a clamp bolted solidly around the pipe, there should be some flexibility between the clamp and the hanger rod so that the clamp can align itself with the pipe when horizontal adjustments of the line occur. This same condition should be provided for with clamp-type supports for vertical lines.

Hangers should permit some slight amount of longitudinal and lateral movement of the pipe, but if this is excessive, as may happen where very long hanger rods are used, some lateral bracing may become necessary to prevent the pipe from swaying. Excessive flexibility and movement of the pipe may cause leakage at the joints and even the blowing out of gaskets, particularly when the softer gasket materials are used.

When wall brackets are used for supporting horizontal runs, the pipe should not be clamped solidly to the bracket, except where it is essential to have an anchor point. The pipe may be laid in cradles on the brackets, or it may be suspended from the bracket by means of a hanger.

If it is necessary to support a valve at some distance from a structure, its supports should be sufficiently stiff to prevent turning forces being transmitted to the pipe.

Two methods may be used for supporting vertical runs of pipe. One method is to use one of the metal flanges at a conveniently located joint. One suitable arrangement using a plate carried on a floor bracket is shown in Fig. 10. Another method is to use a split clamp, tightened around the pipe, with some resilient padding between the clamp and the pipe, as indicated in Fig. 11. If the surfaces producing the pressure on the pipe are not accurately formed, or if the bolts are overtightened, undue stresses may be exerted in the pipe, so that the former method is generally considered preferable of the two.

In the case of milk lines, it is frequently desirable to connect a run of glass piping to a stainless steel line which must be dismantled at frequent intervals for cleaning. In such a case, a short stainless steel adaptor should be connected to the glass line and supported with a bracket so that the glass line will be held firmly and protected while the metal pipe is dismantled.

If positive displacement pumps are used in connection with glass lines, they should be furnished with some type of relief valve which can be set at a pressure not greatly higher than the recommended working pressure for the pipe.

When the line is completely installed, it should be pressure tested with water or other liquid, never with air. A pressure 25% above the recommended working pressure of the pipe can be applied for a short time for this purpose. Joints showing any tendency to leak should be tightened further, but not greatly over the

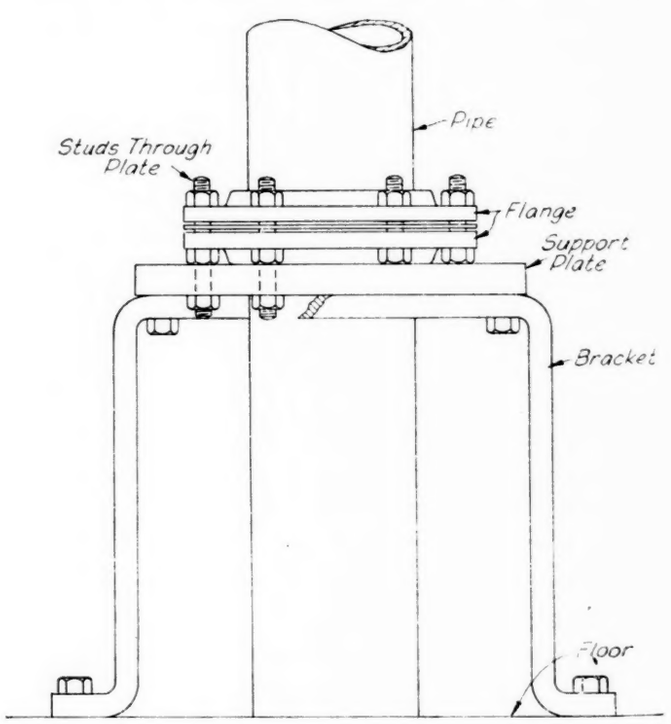

Fig. 10. Vertical support for glass pipe using ring plate under flange.

torque values recommended for the bolts. In most cases, any leakage will stop after the gaskets have a chance to compress over a few hours. If leakage continues, the joint should be dismantled and carefully inspected to determine whether or not it has been installed properly, the flanges lined up in parallelism, etc. A new gasket should be used at the time the joint is reconnected.

All joints should be retightened after 24 or 48 hours because of the permanent set which occurs in the gaskets and inserts.

Repairs and Line Changes

Glass pipe lines, well laid out, carefully installed and operated within recommended limits, can be depended upon to give reliable service. However, provision must be made to take care of line failures, which may result from some abnormal operating condition or an accident. In such cases, the line must be shut down, the broken section or fitting removed and replaced with a new piece. Mention was made previously of the desirability of having replacement parts available. However, there are many practical situations where line modifications are required, such as a valve placed in a new location. As a consequence, the maintenance group may require special lengths which are not available. This situation can be taken care of in various ways.

(1) Straight sections can be made up to special lengths with the beaded flange (page 72), using a beading kit. This type of joint has given excellent service where softer interface gaskets are suitable, and, preferably, where the fluid pressures are somewhat below the 50 lb per sq in. recommended maximum value.

(2) Some chemical plants with relatively extensive systems of glass piping are equipped to carry out sealing operations on the pipe, utilizing either gas flames, or high-frequency electric arcs for this operation. In such cases, sections of pipe are cut and sealed together to form the required length. For piping with tempered flanges, the seal should be made at some little distance from the flanges so that the tempering stresses will not be disturbed by the high temperatures used in the sealing and annealing operations.

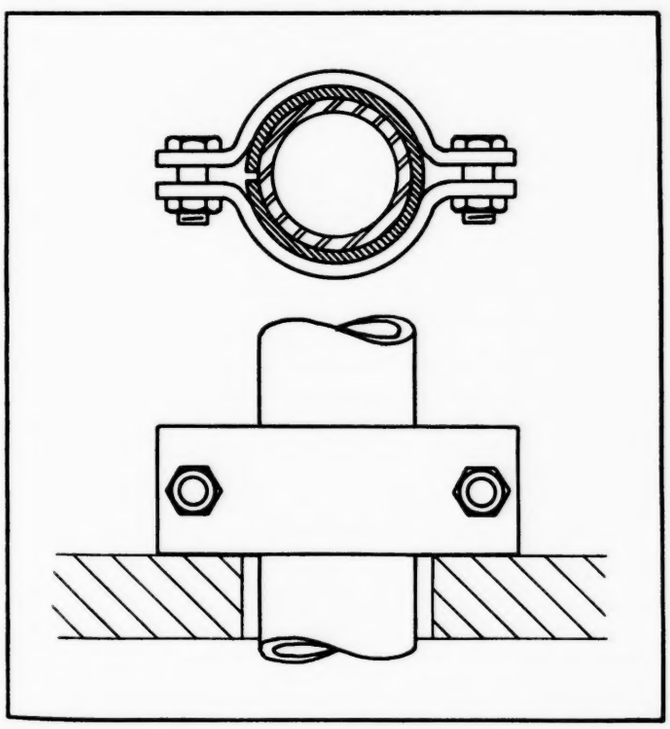

Fig. 11. Vertical support for glass pipe using split clamping ring.

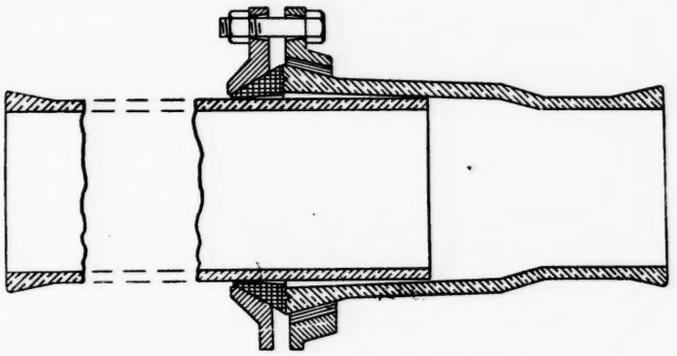

Fig. 12. Repair section made with slip joint.

(3) Repair sections can be made up by combining a straight section of pipe cut off at one end to the proper length, with parts of a slip joint, as indicated in Fig. 12. This type of repair section has the advantage that it can be prepared and installed within a very short time so that the consequent loss of production is reduced to a minimum.

(4) Some plants maintain a stock of straight flanged sections in certain lengths; for instance, in even feet, and also spacers of different lengths which can be inserted with gaskets between the two flanges of a joint. In this way, a composite section consisting of one length of pipe, and one or more spacers can be assembled to provide any length within narrow limits. Tie-bolts are used between the two flanges enclosing the spaces.

Beading Kit

This standard kit consists of simple equipment for cutting pipe to length, and then forming a rounded bead at the cut end.

The cutting of the pipe is accomplished with a Nichrome wire mounted in an insulating holder, and heated by electric current obtained from a low voltage, variable ratio transformer. After the wire heats a narrow stripe around the surface of the pipe, it is removed quickly and this stripe is then quickly chilled with water which produces a fracture along the line of contact of the wire, Fig. 13.

After the cut is completed, the pipe is then laid on roller supports, so that the end is held centrally in the flame of a ring-type gas burner of an appropriate size, Fig. 14. The pipe is rotated slowly until the glass at the very end of the cut softens. The pipe is then withdrawn from the burner and is then rotated or whirled on the kit's roller supports. The combined effect of the centrifugal forces produced, and the surface ten-

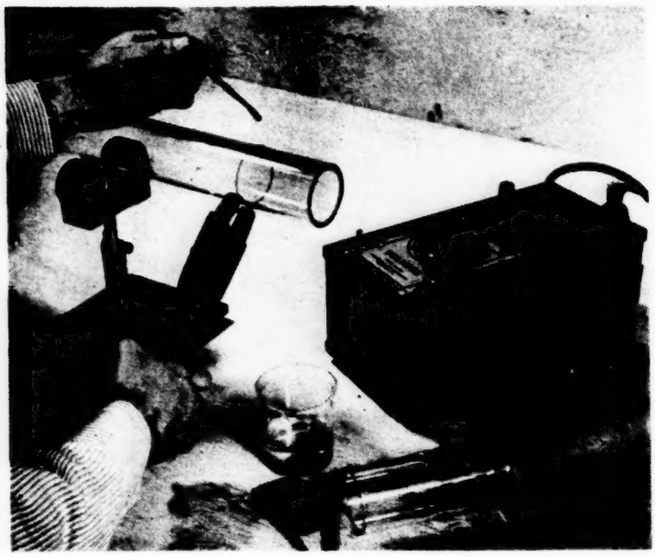

Fig. 13. Electrical kit for cutting glass pipe.

sion of the molten glass produce a smooth bead around the open end of the pipe. The bead is then given a flame-annealing in the burner. When cool, and after the flanges and accessories of the joint are assembled on the pipe, the pipe length is ready to be installed in the line.

High Frequency Sealing Unit

Glass piping can also be sealed on the job, using electric currents. This equipment consists of a high-frequency electric generator or convertor electric torches, jigs, an electric pipe annealer, and the cut-off equipment of the beading kit. Its use is justified only in those cases where an extensive system of glass pipe lines is involved. It can be used for fabricating special pipe lengths, for standard fittings, and for special fittings for complex piping arrangements which can best be custom made on the job.

Straight lengths of pipe can be fabricated by splicing two pieces of piping which already have the tempered conical flanges. For instance, a 6½-ft length of pipe can be fabricated by cutting 3½ ft out of the center of a 10-ft length and then splicing the two end sections together. Fittings fabricated in the field cannot be tempered so that they will have strength equivalent to the factory made tempered fittings. However, many annealed fittings so fabricated in the field have excellent service records and have given the user satisfactory service.

Slip Joints

Repairs on chemical lines can also be made with slip joints, although they do not have the sanitary qualities required for milk lines. The outer shell of the slip joint can be used with a piece of straight pipe with a conical flange on one end and a plain cut at the other end. This piece may be cut to length with the hot-wire cutter of the beading kit. The joint can then be assembled in the normal manner, as shown in Fig. 12, although tie-rods may be required to prevent the joint from pulling apart under the longitudinal forces set up by the pressure of the internal fluid.

Cleaning and Sanitation

Great advantages have resulted from the use of industrial glass piping in the food industry, particularly for milk. Glass has a smooth, hard surface which minimizes the possibility of foreign material lodging in or adhering to these surfaces; cleaning and sterilizing of pipe lines, therefore, presents an entirely different problem than in the case of metals and other materials. Glass piping can be cleaned and sterilized without brushing or scouring the surfaces, by circulating detergents and sterilizing solutions through the lines.

The inner surface of the entire glass pipe line is available for visual inspection at all times. If milkstone or any other deposit, which might impair the sterility of the line, begins to form on any of the glass surfaces, it is at once apparent so steps can be taken for its removal.

The following summarizes a method generally adopted for cleaning and sterilizing milk lines.

(1) Immediately after the milk run is completed, flush the lines with cold water.
(2) Insert a sponge 2½ to 3 times the diameter of the line, in the inlet end, and then with the cold water pressure, force it through the entire line.
(3) Flush line with water until the water runs clear.
(4) Circulate cleaning solution. Various types of detergents may be used. One containing a wetting agent is recommended. This detergent is mixed in warm water in the detergent tank—usually 0.25 to 1% by weight. This cleaning solution is recirculated through the line by a pump for a period of 15 minutes to 1 hour. When this period is ended, a sponge is usually forced through the line by means of the cleaning solution to remove any deposit which still remains on the glass surfaces.
(5) After draining the line, all metal parts, such as valves, stainless steel connections, pumps, and other equipment are dismantled, scrubbed and reassembled in the line.
(6) The pipe line is then sterilized by one of three methods—circulation of chlorine solution, at least 100 ppm; circulation of hot water at 180-

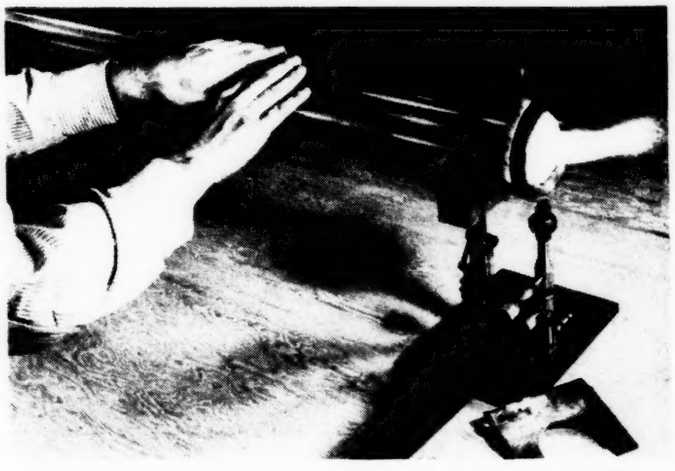

Fig. 14. Beading or field flanging glass pipe.

190F for 5 minutes; bleed low pressure steam (15psi) through the line until the complete system has reached sterilizing temperature.

(7) Allow the line to drain and then cap the ends until the next run of milk. Milk lines should be arranged so that a continuous circuit of pipe can be set up during the cleaning operation to permit recirculation of the detergents.

In other branches of the food industry, as in canning plants and wineries, the cleaning operation is not ordinarily as elaborate as in the case of milk. Frequently, it is adequate to flush out the line with cold water, and then follow this with the use of low pressure steam.

Fluid Friction in Glass Piping

The phenomenon of fluid friction in glass piping does not differ from that in other types of piping. Glass has a much smoother surface than the metal in commercial piping, which tends to give it a somewhat lower friction coefficient, but for the range of Reynold's numbers found in the normal operation of glass pipe lines, the difference in friction between glass and other "smooth pipes" is inappreciable, as is indicated by the analysis given by Moody (4).

Methods of calculating pipe friction using the Fanning or Darcy friction factor are available in many articles and textbooks.

Experimental data taken over a somewhat limited range of conditions indicate that the friction drop in glass fittings tends to be slightly lower than in screwed metal fittings. Values given by Perry (5), Generaux (6) and Lapple (7) for fittings can be accepted as being amply conservative.

The friction drop in fittings and valves can be expressed in terms of either an equivalent number of pipe diameters, L_e/D, or in the number of velocity heads lost, $\triangle p$. Lapple presents his data in both terms.

In the following example:

L_e/D = equivalent length of pipe to be added to straight runs

$\triangle p$ = velocity head added by fitting

$\triangle p = \frac{V^2}{2g}$ in feet head of fluid involved

V = velocity in feet per second

g = gravitational constant = 32.2.

TABLE 11—FRICTION LOSSES IN COMMON FITTINGS

Fitting	Friction Loss	
	L_e/D	Δp
45 deg L, standard radius	15	0.3
45 deg L, mitered	....	0.23
90 deg L, standard radius	32	0.74
90 deg L, long sweep	20	0.46
90 deg, mitered	60	1.30
180 deg, close return bend	75	1.70
180 deg, medium radius	50	1.20
Tee—along run—branch blanked off	20	0.40
Tee—used as L, entering run	60	1.30
Tee—used as L, entering branch	70	1.50

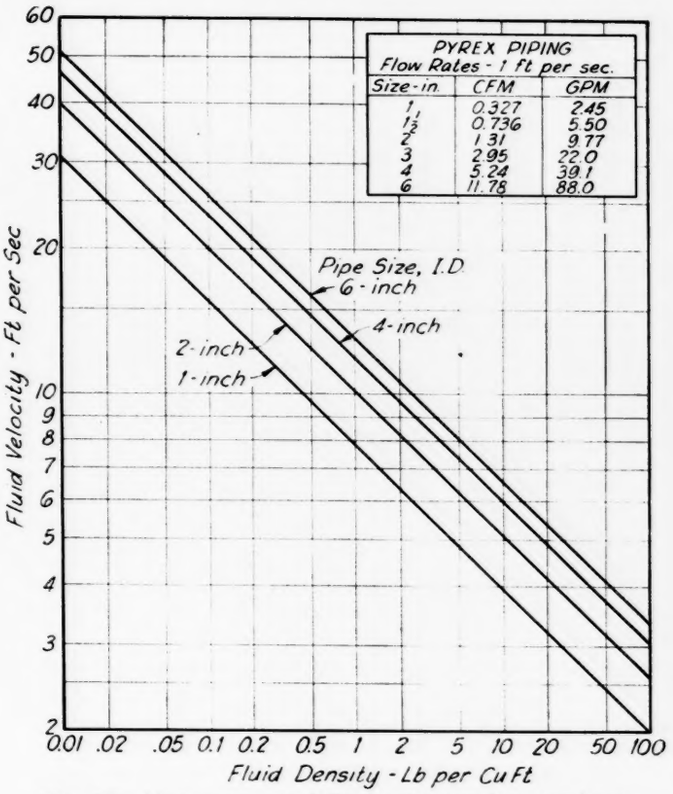

Fig. 15. Most economical fluid velocities for pipe lines.

If the equivalent number of diameters is found to be, $L_e/D = 40$, then for a 2-inch pipe, $\frac{40 \times 2}{12}$ or 6.7 ft will be added to the actual length of the straight run to take care of the fitting. If the velocity head is used, $\triangle p = 1.0$, then the loss of head of a fluid velocity of 4 ft per sec will be $\frac{V^2}{2g} = \frac{16}{64.4} = 0.25$ ft of head loss for the fluid under consideration. For water, this would equal a pressure drop of $0.434 \times .25 = 0.107$ lb per sq in.

Table 11, taken from Lapple, gives the relative friction losses in common fittings.

For convenience in making first approximations of sizes suitable for required rates of flow of fluids of various densities, Fig. 15 may be used (11).

Piping Costs

No accurate estimating costs can be given for a unit length of industrial glass pipe line because factors such as the duty of the line, complexity of layout and conditions of installation may vary greatly from one installation to another. Average figures compiled from the requirements of many users indicate that the material costs can be approximated somewhat as shown in Table 12. The only accurate method of determining costs for a specific pipe line is from the actual bill of material and the price lists for the items required.

Comparative cost analyses have been made which permit some estimate to be made of relative costs of various types of pipe lines. In general, it can be said that these analyses indicate that glass pipe lines are considerably lower in cost than most corrosive mate-

TABLE 12—MATERIAL COSTS PER FOOT OF GLASS PIPING

Pipe Size, Inches	Material Costs, Dollars per Foot*	
	Simple Layouts	Complex Layouts
1	1.75	3.00
1½	2.60	4.00
2	3.25	5.25
3	6.50	7.75
4	8.00	13.00
6	14.00	20.00

*These costs include straight sections, fittings, metal flanges, gaskets, all without spares.

rials, and are as low as any material which will meet strict requirements for sanitary service. Table 13 includes the results of two of these cost studies. These comparisons appear to be confirmed in a general way by the experience of industrial users. Dairies have reported that the cost of glass lines installed is lower than that of sanitary stainless steel lines.

Data available on costs of installation show considerable variation. Under normal conditions, installation costs do not appear to be materially out of line with those for metal pipe lines. One piping contractor has reported that the installation of glass piping in a chemical plant was simpler and required fewer manhours than threaded metal piping. An exception to this has been reported for the installation of the glass piping at Oak Ridge, Tenn., where it was found that the installation of glass piping was approximately double the cost for installing stainless steel lines (8). However, in reviewing the details of these particular lines (1), it is believed that this particular installation cannot be considered at all typical of ordinary industrial practice because of the extent to which the fabrications of special glass parts was carried out at the point of installation.

Maintenance Costs

Annual maintenance costs of glass pipe lines have been reported over a range from 2 or 3% to 8%. These costs will vary considerably, depending upon the corrosive effect of the fluid handled on both the pipe and the gasket materials, and upon other conditions of operation.

Users have reported almost complete freedom from breakage for glass pipe lines over extended periods of service. In one instance, a glass pipe line had experienced no failure at the end of seven years.

TABLE 13—COMPARATIVE COSTS OF PIPE LINES

Material	Relative Cost, %	
	Installed[1]	Material Only[2]
Glass (Pyrex Piping)	100[3]	100
Lead (pure, no supports)	93	.....
Porcelain	190	102
Hard rubber	.....	129
Stainless steel		
No. 304 Zephyr wt. welded	120	.....
No. 316 Zephyr wt. welded	176	.....
No. 316 or 347 Std. wt.—Screwed	460	.....
Rubber-lined steel	160	129 to 143
Saran-lined steel	.....	174 to 194
Glass-lined steel	.....	280
Duriron	290	.....

[1]Installed cost of 250 ft pipe plus 1 tee and 1 valve—average of 2- and 4-inch sizes (9).
[2]Material costs only for piping layout for 86 chlorine cells involving 600 ft of 2-, 3-, 4- and 6-inch piping with 40 ells and 40 tees (10).
[3]Includes stainless steel valve.

As already mentioned, the use of tempered fittings and flanges, together with the use of care in layout and installation, are important factors in the elimination of failure and meeting low maintenance costs.

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Errors Often Made in Forced Hot Water Heating Systems

T. W. REYNOLDS

In connection with forced hot water heating systems, where is the best location of the pump or circulator, what is its proper position and why? How does a safety loop work and where is it needed? When are special fittings at boiler and mains required and why? Troubled inquiries from designers and installers, and jobs that do not work, show the need of more light on these and kindred items as given in this two-part article. Part 1, presented this month, deals with the safety loop, water circulation, and special tank fittings.

Part 1

MOST confusion in forced hot water heating work seems to exist in connection with the safety loop (Fig. 1 and 2). This device has been called a breathing, balancing, equalizer, circulating, or safety loop, according to the person. Furthermore, the same person will give it different names at different times. Explanations of its purpose, operation, and where needed, also become widely divergent. In actuality, the loop does not function in accordance with the first four names, because any expansion or pressure differences in the boiler, when the burner is on with the circulator off, can be relieved or equalized, if necessary, backward through the circulator.

How the Need for a Safety Loop Arose

This need for a safety loop in closed systems under certain conditions of their operation or elevation of radiation was forcibly brought out in connection with a group of 500 residences (Fig. 1). In this group, the radiation was free-standing, down fed, and, together with mains, was all at low level or boiler room floor. Originally, the water in the boilers became very hot, even to the point of possible rupture of cast iron boiler sections. Yet, as determined by thermometers in cross fittings of piping, there was no increase in temperature in the return lines, regardless of high boiler temperatures.

As reports came in from this housing development about broken boilers[1], particularly where sections were improperly drawn up, and of water not circulating throughout the entire system (despite the pump), it became necessary to quickly locate the source of trouble and determine the remedy. The solution was the installation of a safety loop as shown in Fig. 1, since which time there have been 1,500 similar installations, all free from trouble.

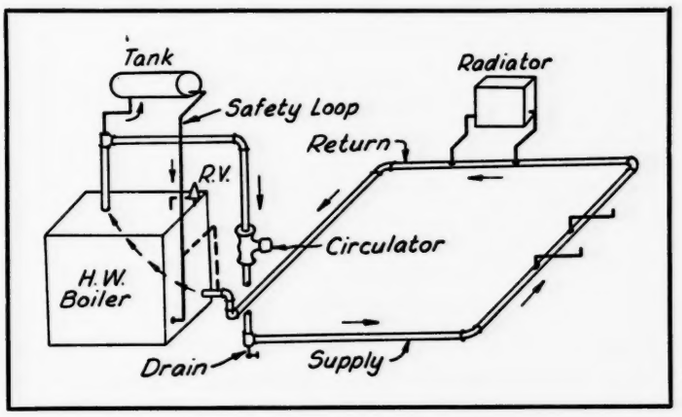


Fig. 1. Safety loop for low level radiation.

In this group of 500 homes, there was one with a radiator on the second floor. This lone installation was trouble-free and therefore pointed the way to the cause of the difficulty in the remaining installations which had nothing but low level radiation. As a consequence, the idea occurred to use the expansion tank immediately over the boiler, in effect, as an upper floor radiator to cool the hottest water, thus causing the water in the loop to circulate back to the return as shown (Fig. 1), yet without any change in the tank itself. The only thing required was the safety loop, which, though patented[2], is but a simple arrangement of small sized pipe connected from the tank to the return main at the boiler. To demonstrate its working, a valve was temporarily installed in the loop, which whenever closed, soon brought back the original trouble.

Difference Between Safety Loops on Steam and Hot Water Boilers

The primary purpose of the loop is to quickly relieve an over-fired boiler of hot spots localized and stagnated within it. These hot spots, of which more hereinafter, tend to rupture a cast iron boiler; hence, their relief by circulation away through the loop makes this loop a safety loop. Nevertheless, it is not a safety loop by pressure equalization, as with the one we are long familiar with in connection with a steam boiler. In the last mentioned case, steam pressure within the boiler presses down on the water within the boiler to

[1]Boilers are lighter today and it is claimed by some that it is the rear section which, being very hot and rigid, breaks due to the introduction direct to this section of either the colder water from the return, or the cold water supply when the boiler water line is raised to normal level too rapidly. Be that as it may for such conditions, in the case cited, the sections no longer broke, once the safety loops were installed. Use, however, two return inlets where there is any doubt on this point of cold water entry.

[2]The patent also covers where mains are overhead down feeding to radiation, as well as where a connection is made direct to the boiler top or to the return with either normal (Fig. 1) or reverse circulation (Fig. 2).

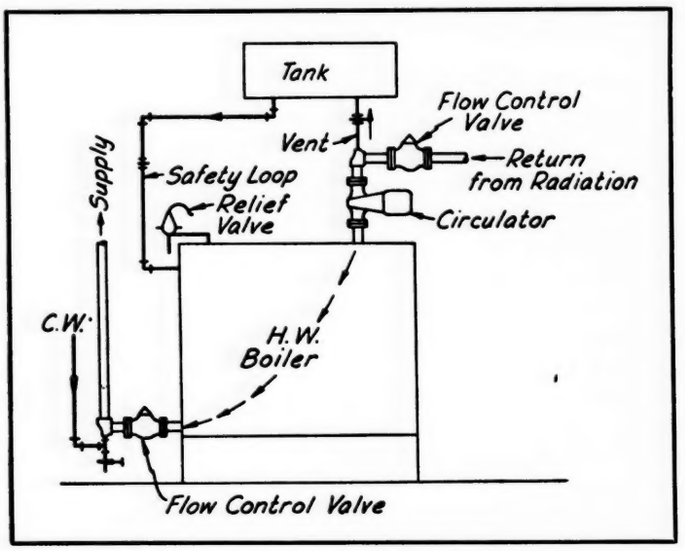


Fig. 2. Reverse circulation through boiler.

force it out through the return to points of lower steam pressure at far end of the system; points where friction of flow and natural condensation have used up much of the original pressure.

Pressure within a steam boiler and at end of return balance only when the steam pressure at far end of the system, plus static pressure of water column backed up or held up in the return, equal the boiler pressure. To prevent this build-up of water column and to return its water to the steam boiler requires an equalizing loop which applies the same pressure on the return water just outside of the boiler as is present on the surface of the water within the boiler.

Such analysis is made here because name similarity has confused the working of a safety loop on a hot water boiler with the function of its predecessor on a steam boiler, whereas safety itself is the only similarity. A cast iron steam boiler gone partially dry can have a too rapid return of condensate to flood dry overheated surfaces. Eventual lowering of boiler pressure allows condensate to return, and in considerable volume, where there is a long dry return too close to boiler water line. Cast iron cannot take the rapid contraction from the sudden cooling by flooding of water on dry overheated surfaces; hence, one or more of the boiler sections crack.

The Cause of Hot Spots in Boilers

Why do we have hot spots in boilers and where do they occur? Well, when a boiler is fired in the laboratory and instruments for temperature indication are located at many points on the boiler, we find certain hot spots caused by unequal heat transfer. These hot spots may come about due to more heat received, or less heat circulated away than is the case at the other spots.

The primary surface is the first to receive the heat of the fire and the only surface to receive it directly, that is, by radiation. It is therefore of primary importance. The secondary surface gets second chance at the heat and indirectly so (convection only). It is therefore of secondary importance. In a cast iron boiler, 40,000 Btu may be absorbed as an average from one square foot of its primary or direct surface, that part which sees the radiant fire. Back in the flues, however, where the surface becomes secondary or indirect, the gases are cooling from continued heat extraction as they exit. The heat transfer may therefore dwindle in the flue ways to only 4,000 or 5,000 Btu on the average.

The front and rear boiler sections have much more total surface (direct plus indirect), while the rear section has the most of both direct and total surface. Even two intermediate sections exactly alike will have different heat transfer, due to localized variations in gas and water flow, flue gas temperature, combustion of fire at different points, and short-circuiting of water to nearest outlet.

How Vapor or Steam Lock Stops Circulation

All hot water boilers have hot spots which generate steam, even though pressure and temperature conditions as read for the boiler indicate that steaming could not occur at such conditions and the boiler as a whole does not generate steam at the low temperatures used. When the steam rises as bubbles from the hot spots, the bubbles have a tendency to be collapsed by the relatively colder water and pressure of the system. However, steam rises rapidly, and if there is too much generation of steam from hot spots, or insufficient circulation to remove the steam bubbles to the expansion tank, it is not possible for the bubbles to be cooled and collapsed. When this occurs, it is possible to produce a vapor lock within the boiler top and at the pump, or in the down pipe (Fig. 1) to the pump. There is then no longer a continuous stream of water in the system and we might have a spot in the piping where it is filled with steam rather than water.

This condition of steam lock may be further complicated by additional steam flash at the circulator. The circulator, being of the centrifugal vacuum type, develops a lower pressure by suction at the pump impellor, thus causing steam to flash at the lower pressure from water which is too hot. The resulting vapor or so-called steam lock will cause the pump to churn, as will any centrifugal pump under such conditions, because there is no solid liquid column to work upon. Small booster pumps of the kind commonly used with hot water heating systems do not have sufficient head to lift the water or break the vapor seal by collapsing the steam bubbles.

Steam Locks Unlocked by the Circulating or Safety Loop

How can we get rid of the hot spots, or at least reduce them to reasonable temperatures? Obviously, this can be done by adequate circulation to remove and vent steam from the boiler hot spots to the expansion tank or to any radiation above the boiler where the bubbles will naturally rise and be condensed by such cooling surfaces, or by the water cooled by such surfaces. Where the radiation is entirely below the boiler, as with radiant heating in floor slab, baseboard, or other low level radiation (Fig. 1), and the job is overfired, then the expansion tank with safety loop provides the only means of relief for lack of circulation due to hot spots.

Of course, steam and air from a boiler could vent to the expansion tank by way of a single connecting pipe from boiler top, provided this pipe can displace an equal volume of tank water counterflow back to the boiler. Likewise, hot water can circulate from boiler to tank to remove heat, provided there is a sufficient circulation. These things in turn depend upon adequate cross-sectional area of pipe, also on a sufficient temperature differential between two columns of water which do not conflict or contact in counterflow; hence, the need of a second pipe to fulfill this requirement. Now the usual pipe from boiler top to tank vents steam and air to the tank and does provide some feeble circulation up and down again, or counterflow within itself. It does not, however, provide adequate circulation for relief of excessive boiling at hot spots. Such relief requires a second pipe as a down column of colder water, in other words, a safety loop is required from the tank to the boiler or return.

With the addition of this circulating loop, the tank serves not only for air collection and expansion of water as heated, but also as a radiator for the condensation of steam bubbles and the cooling of water for the same purpose. The bigger the tank, the more it cools, and the greater will be the circulation to and from the boiler to cool its hot spots and remove their steam bubbles. The loop is most needed and is most effective when the circulator stops. At such times circulation within the loop does not stop, but continues by gravity to cool as compensation for continued burner operation, or for override due to residual heat.

Steam Lock Occurs Generally with Low Level Radiation, Especially Under Certain Conditions

Steam lock is possible on heating systems having the radiation and/or mains below the level of the boiler top (Fig. 1). This is due to the small amount of space in boiler top for storage of the steam bubbles without overflow of these bubbles to the distribution system. If there were also high level radiation the bubbles could be cooled and condensed in such radiation.

While steam lock is possible with low level radiation, it normally occurs only when accompanied with overfired boilers, or wherever fires are uncontrolled (such as with hand-fired boilers), or in stoker-fired systems where residual heat overrides as the stoker stops. Gas-fired boilers are not apt to give trouble, due to only slight residual heat remaining after the burner is out. Combination upfeed and downfeed systems should give no trouble, due to the natural circulation set up by higher radiators and the greater static pressure imposed on steam bubbles in radiators on lower floors.

Setting the pressure reducing valve to admit more of city water pressure (where higher water pressures are still reasonable) may raise boiling points to prevent formation of steam bubbles or help slightly to collapse them if they do form. Still other helps are low position of circulator (Fig. 1) (to give a slightly higher static pressure on the suction side of the circulator), reverse flow through the boiler (Fig. 2) and location of circulator on the colder water of the return (Fig. 3).

Although the loop is primarily proposed for systems with low level radiation (Fig. 1), it can be used with any other arrangement if deemed advisable. It should be used wherever there is any possibility of localized steaming due to an over-fired condition or the use of high temperature water. It may, in some cases, become a desirable economy in first cost to use high temperatures to develop 240 Btu from each square foot of radiation for peak loads. While the normal use of only 200 Btu in our calculations provides a good safety factor, it does require additional space for radiation and ties up more money in excess radiation just to satisfy a few peak days of the heating season.

Smudging of walls by heat flow from baseboard radiation and override of space temperature does tend to increase with higher water temperatures. Nevertheless, smudging may be kept down to a minimum by providing front outlet grilles for baseboard radiation. The front outlet diffuses the air from the outlet with that of the room, thus lowering the velocity of air by the time it contacts the wall and causing the resulting air mixture to contact the wall at a much higher point.

How the Loop Should be Connected with Respect to Boiler, Tank and Circulator

The down flowing pipe from the boiler is called the loop. In reality it is only part of the loop, the part that completes the loop to make circulation possible in both the up pipe from boiler top to tank and the down pipe from tank to the return main. Therefore, any form of connection is satisfactory which makes a complete loop to allow circulation by gravity when the pump is stopped. This being so, the loop may be connected to either the top (Fig. 2) or bottom of the boiler (Fig. 1), or to the return main entering the bottom

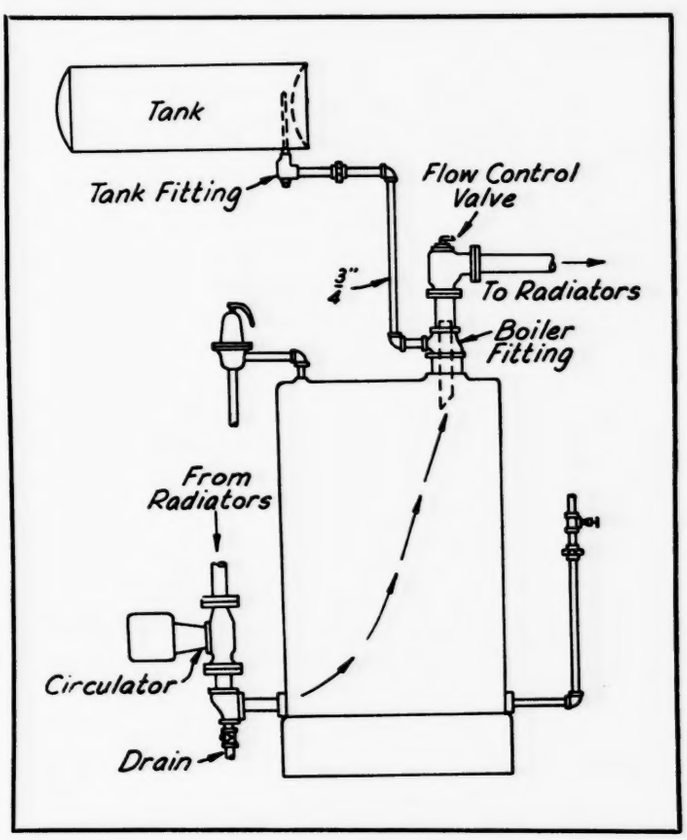


Fig. 3. Arrangement for directing air to tank.

of the boiler, as shown dotted in Fig. 1, and to either the suction or discharge side of a low circulator when such connection allows recirculation to the boiler to continue when the burner is off.

When connected to the suction side of the circulator, there is possibly a very slight increase of circulation in the loop by induction of the return flow, also some remote chance of steam bubbles forming at the suction side of the circulator. When connected to the discharge side of the circulator, the water flow in the loop might be reversed while the circulator is running, in which event the cooler return water would give greater cooling and condensation of steam bubbles in the top of the boiler. These are all things which occur, if they do, when the circulator is running, but what we should be most concerned with is the degree of circulation in the loop only when the circulator is off.

Since the purpose of the loop is to circulate, it should be of adequate cross-sectional area, short and direct without unnecessary fittings to interpose additional resistance, and preferably have additional height of cold water column by going to the bottom of the boiler (Fig. 1), or to where it can be fitted conveniently to the return pipe at the boiler bottom, as shown dotted in Fig. 1. A ½-inch loop will give adequate circulation, and should any excess circulation exist it can be throttled by a globe valve in the loop. The tank and both its connections to boiler should not be insulated.

When there are two pipes (thus constituting a safety loop), the special tank fitting (Fig. 4) normally used and later described should be omitted, because the special fitting is designed to limit circulation in a single pipe, as otherwise used between boiler and tank. As the burner goes off and the system cools, return of water from tank to boiler in a single pipe will normally bring back too much of reabsorbed air by the colder water, thus the tank will eventually be robbed of air and water-log. The special tank fittings prevents this and also directs air to the tank while providing for a return from tank to boiler of only that amount of water displaced by the air. At first thought, it may also appear that the circulating or safety loop will also bring back reabsorbed air; however, the loop is intended for use only in low level installations where the water is liable to form non-circulating steam bubbles. Water in such installations, being too hot, can only release air in the expansion tank and is not able to reabsorb it.

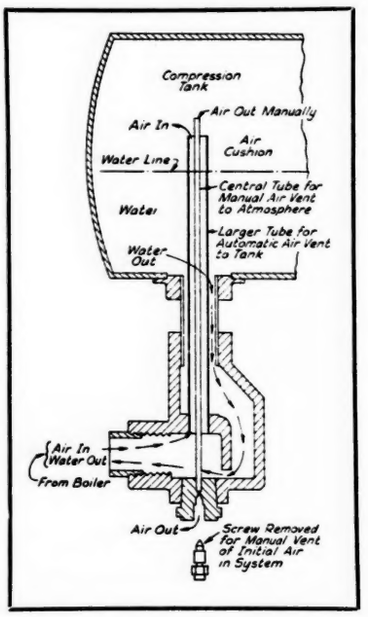


Fig. 4. Tank fitting to separate air and water.

The main point to be concerned with when a safety loop is used is that the expansion tank with its connecting piping may be a heat loss producer by virtue of uncovered surfaces. This heat may or may not be lost, or of any moment, dependent upon the location of the equipment with respect to warming basement or floor above. In any event, it is a definite heat loss during such time as the boiler is operated solely for domestic hot water supply during the summer months. Closing a valve in the loop will prevent this summer loss, placing the valve, of course, in the down pipe of the loop, otherwise expansion of boiler water to the tank could not take place without real trouble.

When the tank fitting is necessarily omitted, as outlined, then some other means must be substituted for convenient draining of a water-logged tank and recharging it with air. This may be done as shown in Fig. 5, where a three-way valve permits temporary closure of the expansion pipe from boiler and at the same time opens the ½-inch draw-off to floor drain. The tank then drains because the ⅛-inch tube in the tank extends through a grid or tapping down to the flap of the valve, thus immediately allowing air from the other side of the flap to flow up through the ⅛-inch tube to above the water in the tank. This admission of atmospheric pressure above the water causes the water to drain from the tank through the ½-inch valve because of the static head of this water.

Should the drain be carelessly left open, some expansion of water from the boiler is still provided for by a drilled opening left in the flap of the valve. The drip from the drain should then be noticeable. If not, however, and the boiler water happens to expand faster than relieved by the drip, then the relief valve will open, in which case the discharge of water would be much more noticeable. Pet-cocks and a water-glass on on the tank are also provided to show water level in the tank.

The Proper Position and Location of the Circulator

Generally speaking, the circulator can be installed in either a horizontal or vertical position and in any location. It can be located at any point in the distributing circuit near or remote from the boiler, installed high (Fig. 2) or low (Fig. 3) with respect to the boiler, or on supply (Fig. 1) or return (Fig. 3) of the boiler. It can operate with normal upward flow through boiler (Fig. 3), or reverse natural flow (Fig. 2) by supplying the system from the bottom boiler tapping normally used as a return inlet, and for each of these two conditions it can take suction from the boiler (Fig. 1), or discharge into it (Fig. 2 and 3).

A circulator located at the top of the boiler will be less accessible. It will also be at high level temperatures and subject to radiation from the boiler. On the other hand, it will be out of the way to save limited space and damage from possible flooding. It should never be low down on a supply main, which, after dropping to such location of circulator, must immediately rise to complicate the piping. Thus, each location has its advantages and disadvantages, slight though they may be. One thing is gained, some other lost, so while there is often a preferred location for certain condi-

tions, the circulator will as a rule be found installed where it is least in the way, takes up less space, or is most easily installed.

Location is one thing, position is another. As for position, most circulators will be found installed in a vertical rather than in a horizontal position. Such position (Fig. 1) takes up less space and generally requires less bends in the piping. It also offers less chance of air binding in the scroll of the circulator and automatically frees the circulator of sediment, as well as all water when draining the system. Here again, the usual will be the thing most contractors seem to prefer as easier to install, that is, the vertical position where the fitter can easily apply the wrench to the circulator at standing level.

Circulator Location with Respect to Temperature. Supply Versus Return

Quite frequently we hear the comment that the circulator should be installed on the return, because there it will operate with a lower temperature of water; however, in a hot water heating system the practical effect is the same when handling either supply or return water. There are conditions of process heating where a 20- or 30-degree temperature differential might have some effect, but on pumping equipment it is rare that such a differential would affect equipment operation in an undesirable way. Scientifically speaking, a circulator will handle less water as temperature increases. Practically speaking, one would be splitting hairs for no purpose in trying to evaluate the difference in circulation rate between the supply and return at the temperatures commonly found in heating systems. Static pressure is still another factor which has no effect on circulator capacity.

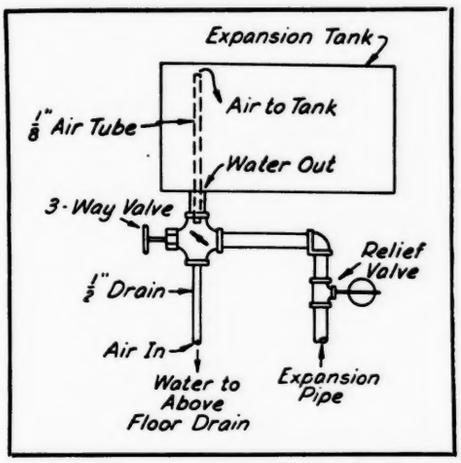


Fig. 5. Tank charger and drainer.

Reverse Circulation for Efficiency and Pressure Relief

Fig. 2 shows reverse circulation. Here, the natural tendency of boiler heated water to rise is opposed by reversing the circulation of hot water to leave the boiler by its normal return inlet. This counterflow of coolant water and hottest gases gives a higher average temperature differential and greater mean temperature difference. There is some evidence that this brings about an increase in boiler efficiency of from 3% to 10%.

There is still another reason for reversed circulation. This is where the water pressure in the system is so high that a high pressure boiler is required unless the total pressure (circulator head plus static pressure of water column height), can be sufficiently reduced by eliminating the direct pressure of the circulator on the boiler, in other words, putting the boiler under suction.

Low pressure boilers and radiators are only guaranteed for 30 lb per sq inch on water and the relief valve at the boiler is set to relieve at this pressure. In some larger installations, pressures as high as 100 ft of head have been used for circulating only. This corresponds to a pressure of about 43 lb per sq inch, which is higher than the relief valve setting, and to this must be added the static pressure of the system. Fig. 6 illustrates the effect of water pressures at various elevations and the need for installing the relief valve at approximately boiler height.

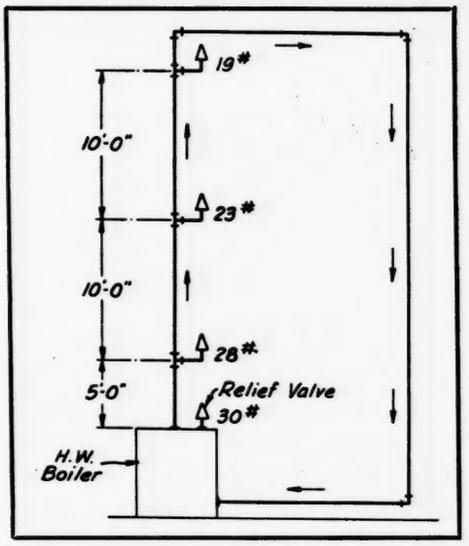


Fig. 6. Effect of pressure at various elevations on relief valve.

Special Fittings at Boiler and Tank

A well known manufacturer makes use of a special tank fitting (Fig. 4) at the inlet to the expansion tank, together with a second special fitting (Fig. 3) of different design for use at the supply outlet of the boiler. The boiler fitting, which will be discussed in detail in Part 2 of this article, frees the boiler and distribution system of air (where it is not wanted) by venting it to the expansion tank (where it is wanted). One feature of the tank fitting is the confinement of air to the tank. Air from the tank cannot return to the boiler.

While the tank fitting is primarily designed with the foregoing purposes in mind, it is also designed to allow initial venting of the system, draw down of any excess water in the tank, and for recharging of the tank with air. For these purposes, the screw at the base of the fitting must be removed. During draw down and recharging, the valve at the circulator must be closed, as should also the special flow valve on the supply. For quicker draw down, a valved draw-off from bottom of tank to floor drain is desirable. To know precisely the amount of air in the tank, a gage glass with try-cocks is also desirable.

The central tube of the tank fitting vents the air manually when desired to atmosphere as explained, but air from the boiler flows to the tank through the area remaining between this central tube and the larger tube in which it is enclosed. The water in the tank, then necessarily displaced by this air, flows back to the boiler through the area remaining between the larger tube and the connecting pipe in which it in turn is enclosed. Displacement of this water takes place through narrow passages and a deflecting web at the base of

the fitting, thus stopping circulation of water in the connecting pipe to and from the boiler, or at least reducing it to a negligible quantity or one which may exist only in theory.

The larger tube containing air terminates above the water level within the tank. This prevents possible counterflow of water against the entering air and also prevents possible circulation of water to and from the tank within this tube and the connecting pipe enclosing it. The two passages, one for air up to the tank, and the other down for displaced water, are kept small and separate, so that they neither conflict nor provide good passages for undesirable circulation of water. The tubes are ordered of length for extension up to about half the diameter of the tank into which they are to be installed.

Should there be no ready means of determining the exact water level in the tank, water may rise to above the larger tube. Even so, any possible circulation of water should be of no moment. Should, however, the tank in time become fully water-logged, a condition rare when a tank fitting is used, then there will be no quick means of draining the tank. So it is advisable to have a brass plug or a pet-cock on top of the tank which when opened allows air with its atmospheric pressure above the water to cause the tank to quickly drain. Air can enter, of course, through the opened draw at bottom of tank, but intermittent small discharges of water in gurgles each time some air manages to get in and displace the water, takes much longer for complete drainage of tank.

As described, the tank fitting eliminates any positive circulation of water between tank and boiler. This is necessary in order to prevent air from being withdrawn from the tank to boiler each time the water cools when the burner goes off. Since the tank loses heat from its radiating surfaces and contains but little water, this water soon cools off. Each time the water cools it reabsorbs air from the tank, because it is a characteristic of water to do so at lower temperatures. The colder water also sets up a return circulation to the boiler where no tank fitting is used.

Each time this process is repeated more air is lost, until in time the tank becomes more or less waterlogged. Furthermore, air as reabsorbed in the water may find its way from the boiler to the system where it may cause air binding. In any event, the tank loses its air cushion and therefore its properties of expansion. Because of this condition, the relief valve will frequently operate to waste water with its contained heat. New water make-up is then required and this must be freed of air.

In an attempt to prevent this circulation, yet avoid the use of a tank fitting, a simple pipe connection from boiler to tank is often used and made only ½ inch in size. With such a small size, water displaced by air cannot return to the boiler; in fact, the pipe is apt to air bind. So the pipe size is then increased to ¾ inch, only to find that the increased circulation brings down too much air-saturated water.

The Increase of Air and Decrease of Water in Modern Systems

Water heated from 150F to 190F will give up about one-half of the air it contained at the lower temperature; therefore, the present-day heating system with its higher operating temperature releases more air per gallon of water and does this in a system of much less volume. In a residence, one finds only a 1¼-inch main with ½-inch branches for 450 sq ft of radiation (Fig. 7) where in former days there would be a 3-inch main with 1-inch branches. This is because of increase in available pressure head with a circulator. Thus a smaller pipe with its increased velocity will carry the same heating load in thermal units as would a larger one in a gravity system.

Of course, the higher temperatures have not affected boiler size, since thermal absorption remains practically the same*, but they have reduced radiator size from 60 sq ft (150 Btu per sq ft with average water temperature of 170F) to 45 sq ft (200 Btu per sq ft with 197F average temperature) (Fig. 7). Radiators have been reduced in still another respect, for as the years have gone by, their volume has decreased from that contained in radiators of elliptical column shape to those of tubular section on large centers, and then short centers, and finally to convectors of extremely small volume. So we now have less water, more air, and smaller areas and spaces for air to restrict, therefore more trouble in hot-water heating systems, unless such systems are designed for prevention of these troubles.

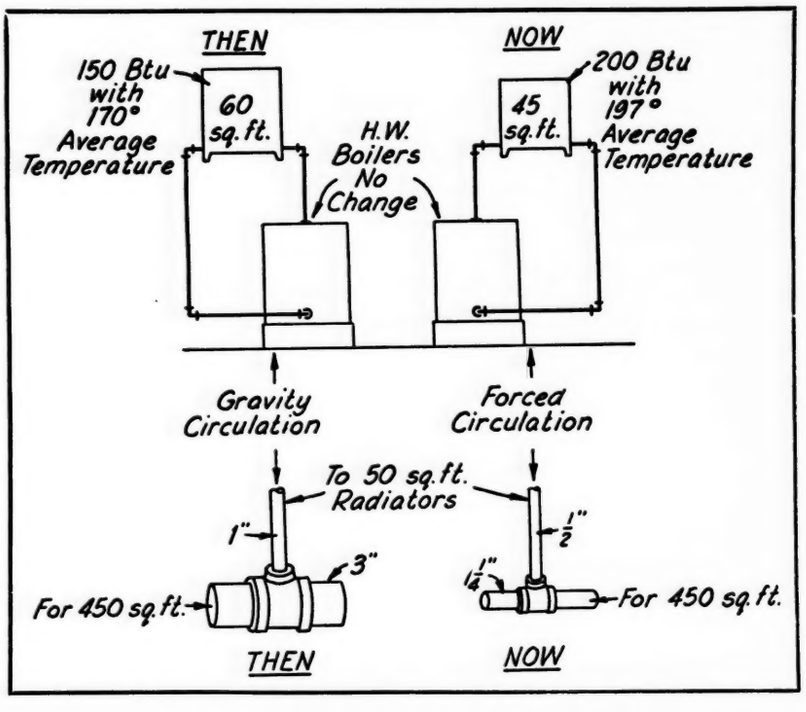


Fig. 7. How radiators and pipes have shrunk.

*Circulators do reduce fuel consumption to a certain extent due to average temperature of boiler water being lower than in old gravity systems where the boilers often had to be forced to produce circulation.

Part 2 of this two-part article will be concluded next month with a discussion of special boiler fittings, expansion tanks, flow control and balance.

Methods of Supporting Pipes

J. E. YORK
Building Service Engineer, Stone & Webster Engineering Corp.

Part 7 of a group of articles that describes and illustrates the various means for supporting pipe lines. This article covers vibration eliminators.

INSTALLATIONS having relatively long pipe runs and used for conveying compressed air, oil, steam and other fluids are subject to a considerable amount of shock and vibration due to the variation in the rate of flow of the fluid, mechanical oscillation and many unknown causes. These shocks and vibrations are apt to be transmitted throughout the length of the line and may cause excessive vibration of portions having a natural frequency close to that of the transmitted vibration.

This vibration, unless properly controlled, can cause considerable damage, such as producing a break in the pipe joints or damaging the equipment to which the pipe is attached. It can also, because of the additional repeated stress it adds to that already existing in the pipe, rupture the pipe itself. In considering the effects of this added repeated stress on the pipe, it must first be kept in mind that in all pipe bends (particularly those of small radii) or in any irregular piece of pipe, there occur concentrated stresses which are often quite high, even going beyond the yield point of the material. For steel pipe, these high stresses will not contribute to failure where the load is constant, because, due to the ductility of the material, plastic flow takes place which results in a more uniform distribution of the stress and consequent lowering of the high stresses. However, this is not true when such members are subjected to cycles of varying stresses, such as those which can be induced by vibration, for then at the points of stress concentration there are started very minute cracks. Under the repetition of load, these keep spreading until failure finally occurs.

It has also been definitely established that even straight pieces of steel pipe which do not incur these high concentrated stresses can fail at a load considerably less than the ultimate strength of the material in tension, when subjected to an alternating stress either completely reversed or varying between a maximum and zero. It has been found that the limiting stress below which steel will not fail due to repetition of stress increases when the stress is not completely reversed. Actually, this means that the smaller the range between the minimum and the maximum stresses, the greater the load the material will endure for an indefinite period.

Keeping the foregoing facts in mind, the importance of providing a means for controlling the shock and vibration can not be emphasized too strongly. Controlled vibration does not necessarily imply that the vibration is eliminated entirely, but it does mean that the amplitude is prevented from reaching dangerous proportions. This safe point is the equivalent of a very small range existing between the minimum and maximum stresses.

Suspension hangers usually employed for supporting a line have little or no effect in restraining any vibration. On the other hand, vibration eliminators, as illustrated, include shock absorption means to exert the desired degree of force in opposition to shock and vibration. Alternate compression of their spring sec-

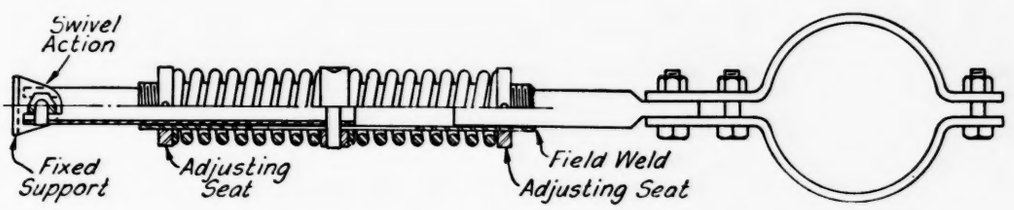


Fig. 109. Vibration eliminator for use where there is ample space.

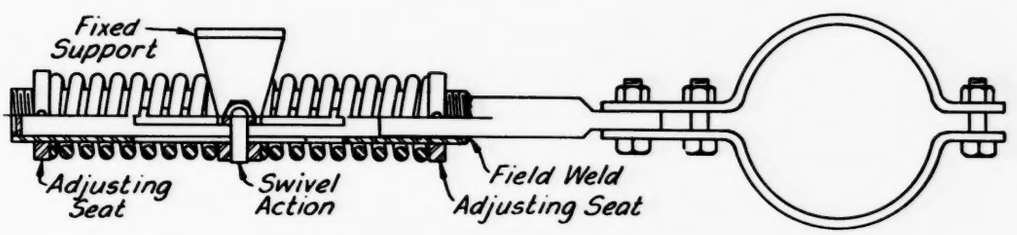


Fig. 110. Vibration eliminator for use where there is a short distance between the pipe and the fixed support.

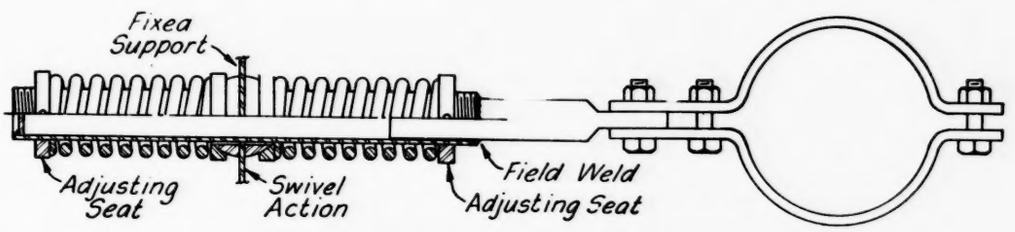


Fig. 111. Vibration eliminator to be used where it is necessary to go through the web of a steel beam or plate.

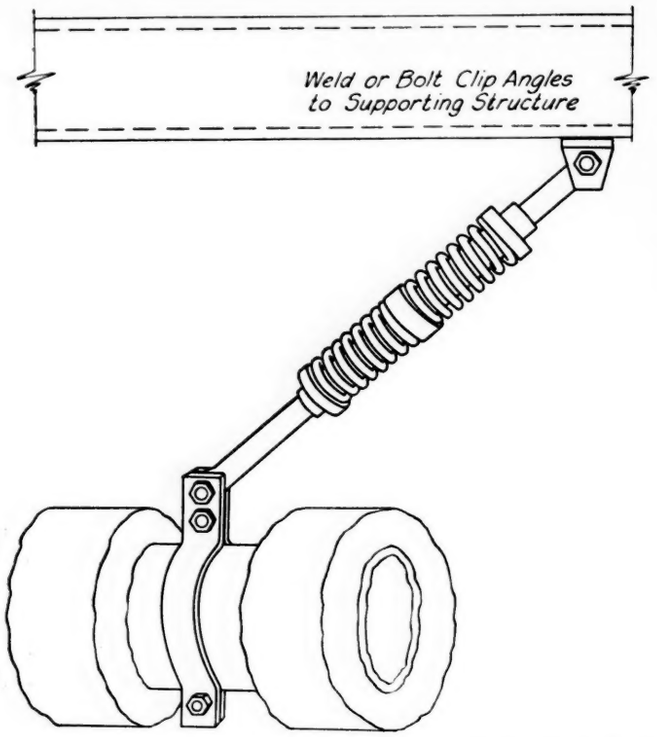


Fig. 112. Vibration eliminator with fixed support at the end.

tions, resulting from any incipient vibration, tends to dampen such vibration promptly and to inhibit it effectively from reaching a dangerous amplitude.

To provide a means for adequately controlling the vibration at practically any desired location in a piping system, the vibration eliminators shown in Fig. 109, 110 and 111 are manufactured by the Blaw-Knox Co. The first of these is for use where there is ample space (3 ft and up) between the center line of the pipe and the point where the fixed support is to be attached. Where the distance between the pipe and the fixed support is too short for use of this type of eliminator, the one shown in Fig. 110 may be used. Fig. 111 illustrates the type that is used where it is necessary to go through the web of a steel beam or steel plate. Each of these types may be obtained for use where the thermal movements of the pipe are normal, or for extreme thermal movement.

As a general rule for selecting the correct vibration eliminator, the size chosen should correspond to the nominal diameter of the pipe. This must be varied somewhat for installations where large masses such as heavy valves are involved, or where repeated heavy impulses are encountered, such as high pressure air lines from a reciprocating compressor.

Installing Vibration Eliminators

To install vibration eliminators, the following step-by-step procedure should be followed:

(1) Place the pipe clamp on the pipe in the location desired.
(2) Insert the extension piece of the assembly in the eliminator.
(3) Bolt the extension piece to the pipe clamp.
(4) Locate the point of fastening clip angles to the structure. By rotating the clamp on the pipe, the eliminator may approach the pipe at almost any angle desired.
(5) Cut the extension piece, if necessary, so that

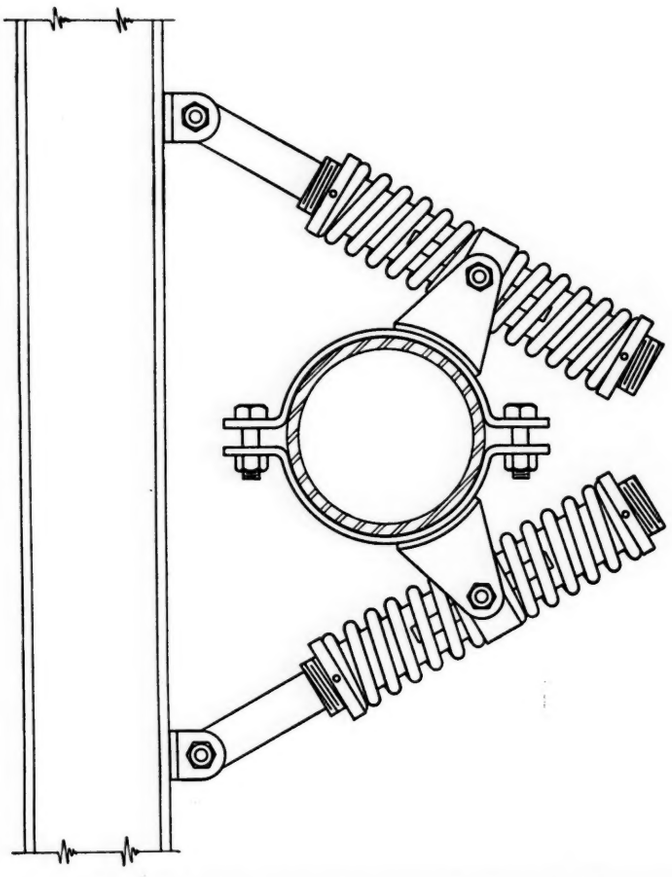


Fig. 113. Special application using two vibration eliminators.

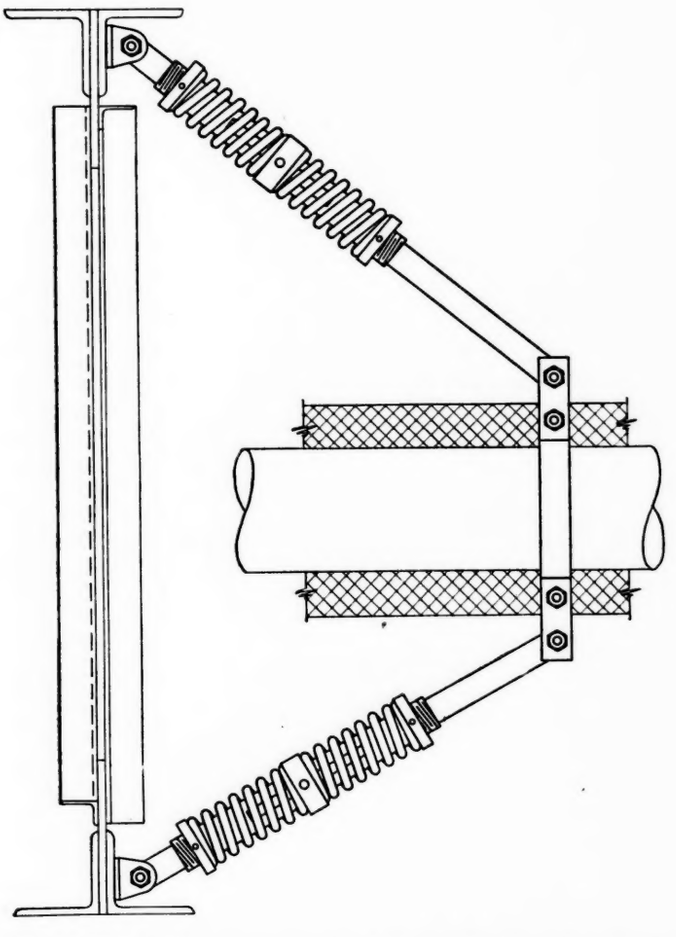


Fig. 114. Another arrangement using two vibration eliminators.

approximately 4 inches of engagement with the body is obtained.

(6) Bolt or weld clip angles to the structure.

(7) Tack weld the clamp to the pipe.

(8) Allow pipe to reach operating temperature.

(9) Weld extension piece to body of eliminator with continuous weld.

(10) If some vibration is still present, the spring tension may be adjusted by loosening the set screws on the two adjusting seats and turning them to vary the tension on the springs. After the desired adjustment is obtained, the set screws should be tightened.

Close clearances are essential between the bolts at the clip angles and at the pipe clamp and their respective drilled holes. Looseness at these points will cause noise and loss of effectiveness of the eliminator.

The following desirable features are incorporated in these vibration eliminators:

(1) They conform to all requirements of the Code for Pressure Piping.

(2) They are so constructed as to permit swivel action in all directions.

(3) It is possible to obtain a modification or desired dampening effect of the springs by adjusting the location of the spring seats.

(4) They provide the means for obtaining and holding the desired degree of force in opposition to the vibration.

(5) The arrangement of the spring seats makes it possible to obtain adjustments whereby no thrust is imposed on the pipe by the springs, when there are no vibrations, or to impose some thrust by the springs in either direction, if that be desirable.

(6) Large range of adjustment expedites installation.

A pipe equipped with a vibration eliminator having its fixed support at the end is shown in Fig. 112. In Fig. 113, 114 and 115 are shown some special uses.

The ordinary spring hanger, in which the piping is suspended directly from or on a spring, offers a supporting effort that varies as the spring is deflected by the expanding or contracting pipe line. The Grinnell constant support hanger shown in Fig. 116 compensates for the variations in spring tension so that its supporting effort is always substantially constant. With its use, the piping may be considered as weightless because it is balanced at all times. It consists of a frame which is secured rigidly to some part of the building structure, a compensating lever and a set of springs. The compensating lever balances the weight of the falling and rising pipe line (suspended from one end) against the pull of the springs which are attached to the other end of the lever. All co-sliding surfaces are hardened, polished and of noncorrosive metal.

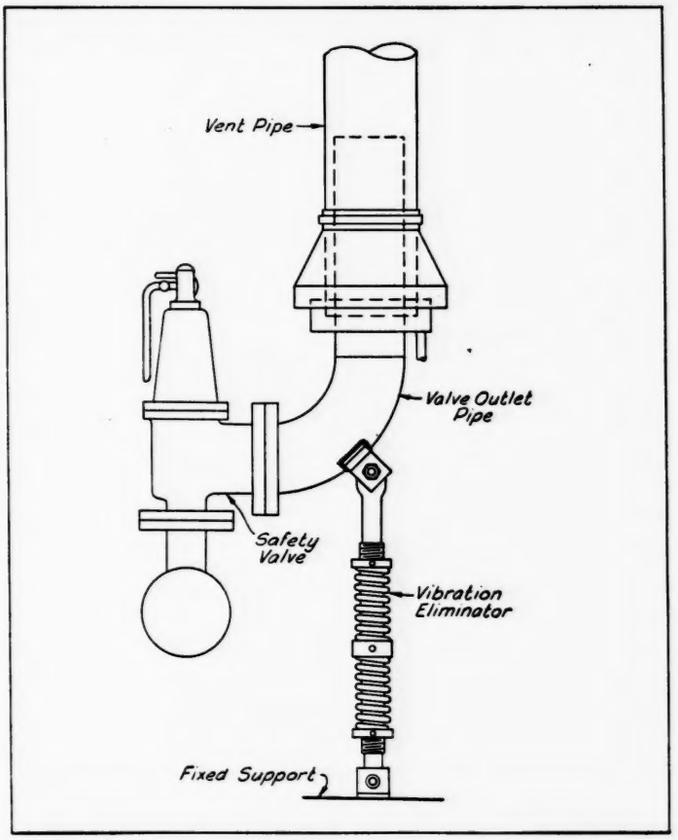


Fig. 115. Method of using vibration eliminator with a pipe elbow.

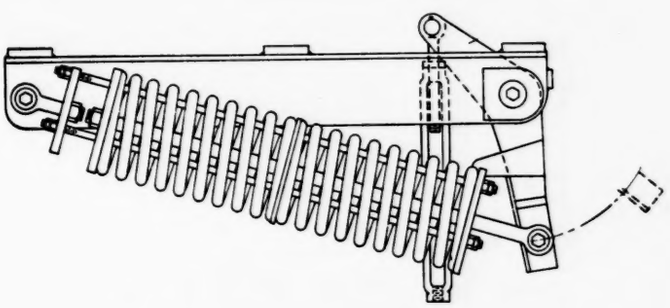


Fig. 116. Grinnell constant support hanger.

Properties of High Temperature Concretes are Studied

Refractory castables, heat-resistant concretes made of a refractory aggregate bonded together with a high-alumina hydraulic cement, are being increasingly utilized in a variety of applications over a wide range of temperature. Typical installations range from the combustion chambers of oil-burning home-heating furnaces to the huge heat-treating furnaces in steel plants. With the recent introduction of a more refractory bonding cement for this material, its field of usefulness may be expected to increase still further in many ways.

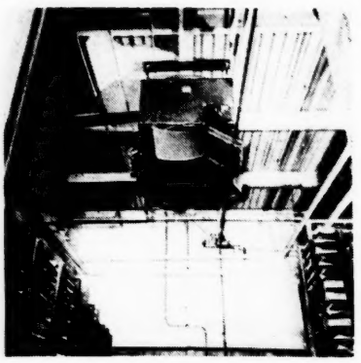
To meet the need for comprehensive data on the preparation and proper use of castable refractories, R. A. Heindl and Z. A. Post of the National Bureau of Standards are conducting an extensive investigation. Results thus far obtained are believed to be of interest to manufacturers of refractory materials as well as to industries which use these materials in furnace construction.

PRODUCT APPLICATIONS

New, Unusual, or Ingenious Uses of Equipment and Materials

Revolving Unit Heater Boosts Drier Capacity

PROBLEM: In the plant of a large manufacturer of pharmaceuticals in New Jersey, production of a new drug necessitated a large increase in drying oven capacity. The existing equipment consisted of seven drying racks in cabinet type driers heated by steam coils. Maximum temperature was 160F and air movement was very limited.



The driers were enclosed by masonry walls in a room 17 x 25 x 16 ft high to reduce heat in the adjacent manufacturing area.

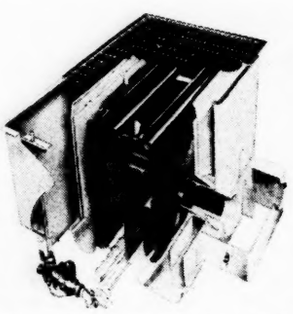
SOLUTION: A single Wing turbine driven unit heater with 4-way revolving discharge outlets was installed, suspended from the ceiling in the center of the room, thereby converting the entire room into one large drier.

RESULTS: The ambient temperature was raised from 160F to over 230F but an automatic control was installed to keep a constant 210F. Uniform temperatures are maintained by the revolving discharge outlets and air movement produced by the turbine driven fan (an electric motor is not usable at such high temperatures). A production increase of over 500% was achieved.

Porcelain Enamel Used for Combustion Chambers

PROBLEM: A gas-fired domestic floor furnace required a combustion chamber with high emissivity, resistant to thermal shock and corrosion by flue gas condensation.

SOLUTION: The combustion chamber of the Temco floor furnace is constructed of porcelain enamel. The porcelain finish is resistant to corrosion and thermal shock because it is a glass-like composition which is fired onto a steel surface at approximately 1600 F. Emissivity of black porcelain enamel steel is higher than that of stainless steel, monel, and other bright finishes.



RESULTS: Temco Inc. of Nashville, Tennessee, provides a 20-year guarantee against the porcelain enamel heat chamber rusting or burning out, and claims greater heat utilization.

Cascaded Compressors Produce Low Temperatures

PROBLEM: Compressors in an engine test room at Hobart Brothers Company were required to simulate severe arctic conditions.

SOLUTION: A tandem arrangement of compressors, called a cascade system, was set up so that one compressor is used to condense the refrigerant in the other. A cooling coil operating with Freon 22 is maintained in a flooded condition by means of a high side float valve. This coil is connected to a 7-cylinder radial Airtemp low stage compressor with 30-hp motor. The low stage is condensed by a high stage unit in a cascade system using a water chiller as the interstage condenser. The high stage unit, charged with Freon 12, has an Airtemp 5-cylinder radial compressor with a standard condenser and a 30-hp motor. Freon 12 is expanded in the tubes of the water chiller, and the condensing Freon 22 is in the shell of the water chiller. Low stage suction pressure is 18 inches Hg and condensing pressure is 30 to 50 lb per sq inch. Average high stage suction pressure is 5 lb per sq inch and condensing pressure is 100 lb per sq inch.

RESULTS: Tests show that this installation will cool the test chamber and a 3,000-lb engine-driven generator from room temperature to —65F in approximately 24 hours. The calculated capacity is 30,000 Btu per hour at —75F suction pressure and + 100F condensing pressure.

Direct-Fired Unit Warms Greenhouse Air Coils

PROBLEM: To heat a small greenhouse with a simple, low cost, automatic heating system and eliminate abrupt temperature fluctuations typical of small greenhouse structures.

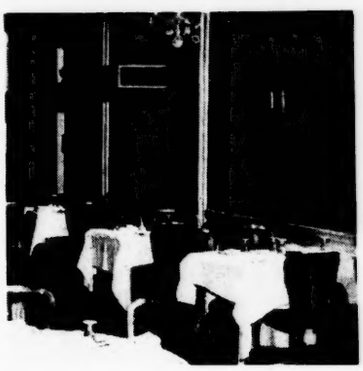
SOLUTION: A pair of raft-like coils fabricated from 6-inch stovepipe was suspended beneath raised benches at the 12 ft by 15 ft Soeten greenhouse, Pasadena, California, and hot air was forced through the coils. The air was then exhausted at very low temperature (same as room temperature) to the outside. A gas-fired Kilbury forced air unvented circulator was used. Because delicate cymbidium (orchid) seedlings were being grown, it was considered desirable to split the piping system into a "Y" with two equally warm pipes following the cold perimeter and returning on the inside. To provide sufficient radiation surface, 156 feet of 6-inch stove-

pipe and 20 elbows were used. To avoid creating a negative pressure inside, 100% outside air was used. The unit was throttled down at the burner gas valve to low gas feed because of the small size of the greenhouse and the high efficiency of the heating system.

RESULTS: According to Mr. Soeten, who also works for the Orchid Research Co., Altadena, the temperature differential within the greenhouse was held to one degree. On coldest nights, with outside temperature as low as 25F, the heater and blower operated in a three-minute on-off cycle, the heater functioning for one minute and fifteen seconds and then remaining shut off for two minutes while inside temperature remained at 70F. On less cold nights the heater operates for one minute in ten. The operating cost during the sixth coldest January on record was only five dollars.

Plenum Chamber Design Can Reduce Duct Work

PROBLEM: In offices and other types of space cooled by packaged air conditioning systems, duct work is frequently required to overcome sectionalization of space in small room divisions.



SOLUTION: Al Weber, design engineer for Typhoon Air Conditioning Co., believes that variations in shape and design of plenum chamber of a packaged unit can often eliminate the need for ducts. In the Unity Club in Brooklyn, for example, a 10-ton type Typhoon unit is installed in the hall adjacent to the main dining room. An attractive tapered 3-way discharge grille projects through the wall and distributes cool air evenly to the dining room. To cool the rear dining room and lobby, short ducts pass along the ceiling to grilles.

RESULT: The packaged unit effectively cools the large broken space with a minimum of duct work.

Rosslyn Metal Used in Space Heaters

PROBLEM: Wesix Electric Heater Co., San Francisco, manufacturers of space heaters, required a heat exchange material with the structural and anti-corrosion characteristics of stainless steel but with a higher conductivity to form a finned metal sheet to enclose the electric heating element.

SOLUTION: The finned enclosure for strip type electric heating elements is formed of Rosslyn metal made by American Cladmetals. This metal consists of a copper core surfaced with stainless steel.

RESULTS: Heat transfer characteristics of copper permit longitudinal fin construction, considered by Wesix to be superior to transverse fins in that they are less expensive, require no welding and accumulate no dust.

Truck Cools and Heats Largest Planes

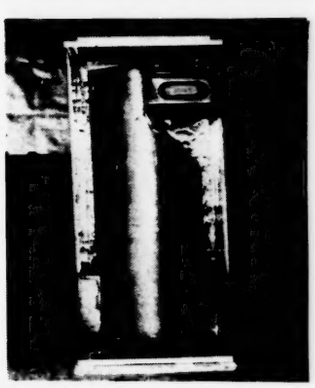
PROBLEM: Large multi-engined passenger aircraft require ground servicing, including air conditioning and heating. Trucks for this purpose have been strained to capacity because they were originally designed for smaller craft.

SOLUTION: The largest mobile aircraft heating and air conditioning unit ever used by commercial airlines has been placed in operation by United Airlines to heat or cool large planes before take-off. Five units will be purchased from Chrysler Airtemp Corp. and placed at key points on the system. Each will have a cooling capacity of 28 tons, 10 tons greater than the next largest unit in airline service. Conditioners can be equipped with a Stewart-Warner heater to heat cabin interiors in the winter-time. Cooling system is designed to cool 2000 cfm at normal operating speeds. Unit with hose attached is mounted on a 1½-ton International Harvester truck chassis with a body designed by Fruehauf Trailer Company.

RESULTS: Cabin temperatures of large planes are brought down or up to comfortable levels in less time than was previously required.

Foil-Faced Glass Insulates Furnace

PROBLEM: Gravity and forced warm air furnaces and packaged unit space heaters have had unusual insulating problems due to the high operating temperature of their heating elements and requirements for compact design, intermittent operation and low temperature of the outer casing. This problem is usually solved by adaptation of an interlining metal shield which provides an insulating air space. This method is disadvantageous in its cost of fabrication and noisy operation during expansion and contraction of the shield.



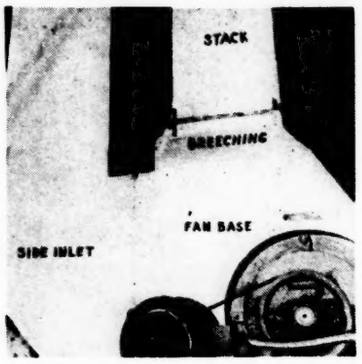
SOLUTION: Latest material designed for this application is Fiberglas foil-faced Aerocor. This product is inserted inside the casing and surrounds the heating element with a bright aluminum surface backed by ½ inch of Fiberglas insulation.

RESULTS: In addition to being economical in fabricating cost, the Aerocor is quiet and reduces the surface temperature of the outer casing below that which is possible with a steel shield. Further reductions in the outside dimensions of the unit are possible.

Induced Draft Stack for Small Plant

PROBLEM: A small but modern laundry in the east had its original stack blown down in 1947. Expanding business required additional power facilities.

SOLUTION: Rather than construct a natural draft stack of a size to accommodate increased power facilities, an induced draft seemed to be the answer. A Prat-Daniel Type 1 fan stack was installed for almost the cost of re-erecting the old natural draft stack.



RESULTS: Additional power is now available from the original boiler and added draft is available should it be necessary to install a dust collector in converting to coal. The possibility of the falling stack has been eliminated in a thickly populated area since, according to the manufacturer, P-D fan stacks are self supporting.

Calrod Heaters Facilitate Oil Transfer

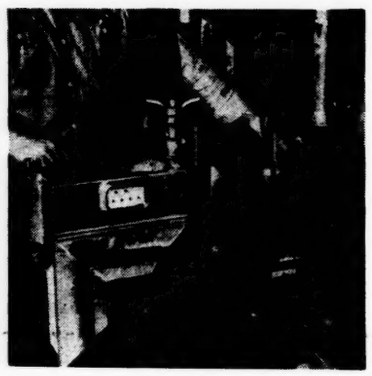
PROBLEM: The handling of extreme pressure lubricants for heavy industrial machinery at Brooks Oil Company required a flow temperature of 375F. Operating costs for high pressure steam heating were high due to heat losses and uneven heat distribution.

SOLUTION: General Electric Calrod tubular heaters were installed on storage tank pipe lines and clamped to the base of each tank. Heat loss was cut by covering with protective layers of sheet metal and asbestos. Thermostatic control provides even distribution of heat throughout the lines.

RESULT: Requirements for high cost steam reduced.

Air Pump Tests Gas Meters

PROBLEM: Gas meters manufactured by Superior Meter Company, Brooklyn, are tested with air for possible leaks within the meter and for insuring accurate calibration. Air must be supplied at constant pressure and volume for testing.



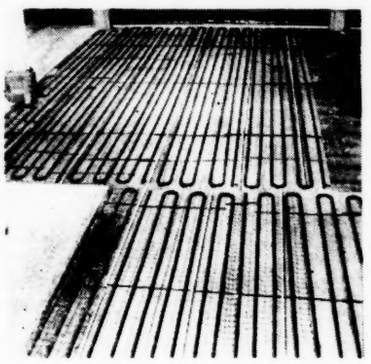
SOLUTION: A single Leiman air pump provides air at about 10 lb per square inch pressure. Air is forced into storage tanks which maintain a constant volume and pressure.

RESULTS: Gas meters are constructed to withstand extreme conditions with little or no attention and are calibrated to within ½ of 1 per cent for volume.

Radiant Slab Laid Over Wooden Floor

PROBLEM: Modernization of St. John's Church in Delphos, Ohio, included plans for a new heating system. Radiant heating was specified in order to retain interior decoration without change, but an existing hardwood floor raised a question as to feasibility.

SOLUTION: The old wood floor of the auditorium was first covered with a layer of aluminum foil paper. On top of this, ¾-inch steel bars were placed at intervals to support steel pipe coils which were laid over and tied to the supporting bars. Coils consisted of 8 sections of 1¼-inch pipe. After hydrostatic testing, a layer of welded wire steel fabric was laid over the entire installation and a 2-inch concrete slab was poured.

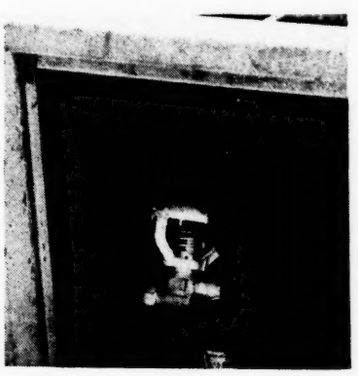


RESULTS: The main auditorium of St. Johns Church, 135 ft long and 65 ft wide, with a vaulted ceiling 60 ft high from floor to roof, is heated satisfactorily. The stone edifice is modernized without changing the beauty of the original structure.

Rubber Sleeves Control Condensation on Pipe

PROBLEM: To prevent condensation on feed and return lines of cooling coils.

SOLUTION: Cellular rubber sleeves were used to prevent condensation on feed and return lines of the climate control equipment installed at 100 Park Ave., N. Y., by Kerby Saunders, Inc., air conditioning engineers of that city. No adhesives or fasteners were necessary because the 1½-inch diameter cellular rubber tubing was slipped over 1-inch copper tube to provide a seamless casing ¼ inch thick. Where joints were required in the copper tube, the rubber sleeve was pulled back to permit sweating the joint, after which the rubber sleeve was replaced.



RESULTS: Tight fit of sleeve prevents moisture from reaching and condensing on cold pipe, and low conductivity of cellular rubber keeps the outside surface temperature of the sleeve above the dewpoint of ambient air, so that condensation does not take place.

Experience is my Classroom

By T. W. REYNOLDS

• BURIED OIL TANKS MAY ARISE AGAIN

Water slight in amount, but sufficient in head or bouyancy, will raise a buried tank to above ground. It happens time and again, even when the concrete mat below the tank is heavy enough as an anchorage in itself, which isn't always. The anchorage straps tied into this mat are quite often not good enough to hold an oil tank down when the tank is less than half full. Straps should be checked for both tension and shear. A welded strap with turnbuckle may be only in tension, but if there are any bolts, they may overlap and get in shear. Tanks should be well anchored, particularly so where buried along the water front, or in excavated beds of former creeks, or in any other location where the ground is wet.

Tanks have been rising above ground for at least 40 years, yet are doing so more today, possibly because there are more tanks. The writer's first experience was with a tank at the General Electric plant in Erie. We knocked off work with the tank dropped in its dry excavation. That night it rained, and the next morning found the tank back at grade again. In this case, there was no anchorage and backfill had yet to be placed.

• THE HUMAN EQUATION

Lack of service and completion of details, improper operation, arbitrary changes by the owner, and field changes in the general space arrangement account for many of the troubles in a new air conditioning system. Aside from these factors, don't always look for defects in the system, for the trouble may lie in a single occupant, hyper-sensitive or otherwise.

In such cases, check the individual rather than the so-called drafty air outlet. Is he or she old, fat, thin, jovial, healthy, heavily or lightly dressed, with a troublesome sinus or perhaps blessed with arthritis? Such persons can make or break the best of systems, especially when they are aggressive complainers and the position they occupy is of importance.

Although the engineer cannot win the argument in cases of this nature, he should not give up at this point and walk out on the trouble. He can go to work on the individual by isolation of the individual in the same space or elsewhere where conditions are better suited, or can be made so. Perhaps the boss can give this party an additional task to make the blood circulate and keep the mind off of troubles. Warmer appearing furniture and warmer colors in surroundings may also be of help.

Never get involved with ventilating your own office—it's too close to home. For instance, the stenographers are located in a stuffy cubby-hole—they frequently are. You move the complaining one to a nearby location of nice air movement and now the light becomes too poor. So she goes back again and you hunt all over until a second-hand fan is found which will take direct current. Small fans using alternating current are easy to locate, but such service run up in an old skyscraper may cost a thousand dollars. The fan itself costs only $20, although the building alteration and slight duct work costs $120.

Everything is set now, except the wiring of the fan, but meanwhile the weather has cooled and a draft from the hall comes through the inoperative fan to the cubby-hole because an adjacent window is open. Now the affected stenographer doesn't like the draft through the fan. Closing the window would stop the draft to the outdoors but she wants the window open for air. She does make the partial concession of admitting that dust no longer comes in through the open window.

I haven't yet found the answer to the rest of this particular problem.

• P. S.

Since the foregoing was written, the answer has been found, but only after considerable trouble. First, the insulation on the fan motor smoked, since the motor soon became overheated. The house electrician said that this was due to worn-out insulation; but one of the office architects, mechanically inclined, tore down the motor one evening and found it to be incorrectly wired. No trouble thereafter from smoking and no trouble from the one stenographer, for work slowed up and necessitated her finding employment elsewhere.

Installation of this small fan seemed to insure against all kinds of troubles. Just prior to the correction in wiring, frequent complaint was made to the secondhand dealer about the odor from the smoking insulation. He finally promised to repair it, but soon his business failed. Inquiry to his last known address brought the reply that the dealer was where he could not answer. Like the business in which he had been engaged, he, too, had passed on.

• FREE ENGINEERING

No manufacturer or agency gives free engineering as he once did, or, if he does, it is very limited in amount and perhaps necessary to the best installation of the product. Free engineering was confined to very

small jobs, usually where no engineering at all would be done if it had to be paid for. Upon occasion a job might be slightly more sizable, but still any fee would be small and for a class of clients who would take too much time to serve them. Free engineering, by pure economics, was always less in amount than thought to be by consulting engineers. The writer never had any particular objections to free engineering, never having been done out of a job by such practice.

Free engineering is not so prevalent as it once was, because the cost to a manufacturer or sales agency for the additional representatives necessary has gone up, but I can recall when a manufacturer or agency would figuratively change the bed sheets of a contractor to get his order. The order, of course, was usually still subject to the price being the lowest to the contractor.

In their eagerness to meet competition on volume orders, each of, say, six representatives of as many different manufacturers would laboriously take off from the plans, and schedule for order, all of the radiators on some large project, and be responsible for the kind and quantity. If they missed here and there a radiator, did not carefully read the subsections of the specifications on radiators, or overlooked some fine print or saving clause elsewhere on the drawings, or in the generalities of the specifications, it had to be made good without any increase in their original bid price.

An agency selling grilles chances many errors in taking off the grilles of so many different sizes from plans full of other work. He finds arrows all over, some of which are for air flow from grilles, and somewhere there is noted a 24 in. grille partially obscured by some electrical note on watts to indicate only a 4 in. grille and such size is accordingly bid upon.

When business is good a manufacturer is apt to withdraw from such practices, or bid high to cover contingencies. At least 10% may be added to bid prices where the order must be taken from plans and specifications, although any take-off of equipment which is summarized or scheduled on the plans by the engineer will be bid at a lower price.

Why should so many bidders do the same job, the job that should be done once only? Why should all have to study out much of the entire project to find out the small part in which they are particularly interested?

• TUBERCULAR BOILERS

The following communication from W. Otto Bros. Maintenance Co. of Forest Hills, Long Island, was noted with interest and since it contained also a compliment was filed in the "Offset File" just opposite the "Brick Bats."

Mr. Otto writes: "Long accustomed to thanking the butcher when he hands me a not-too-big T-bone steak (fat, tail, and all), its a cinch to spare time for expressing appreciation of your publication in general and the column by T. W. Reynolds in particular. For an engineer, he shows extraordinary perception of the things that really matter to the man who has to get things done. For example, the fuel oil heater problem on page 96 of the April, 1950, issue is one of these things the contractor likes to read.

"Perhaps space can be found in the column for the low-down on retubing of commercial and domestic heating boilers, including the garden variety of high pressure (100 lb) boilers. How can one specify the best kind of tubes and make certain of more than a promise of a good job by the boiler contractor? There should be a sort of standard procedure to be written into the contract. The matter of the mill certificate also needs airing. Dirty work at the crossroads."

In reply to Mr. Otto, I would say that there are quite a few things I have done and even more that I haven't. One of the latter is the making of boilers. However, from long experience we all know that the tubes are the weak point of a boiler, the same as the strings on a violin. Some day someone will make tubes in stainless steel or some material that will last as long as the boiler. Not so long ago we could specify tubes of charcoal iron, now no longer available; this is also true of copper alloy tubes.

Using what is available, we specify seamless or electric welded tubes. Seamless tubes are mostly used, and the Board of Education of New York City has some ASTM number in their specifications which I won't look up as I have faith in what the leading boiler manufacturers regularly furnish from well-known makers of steel products. No manufacturer would take a good boiler and cheapen it by furnishing poor trim or tubes anymore than a clothier would sew cheap buttons on a good suit of clothes. As for the mill certificate, this is just a certification of quality of tubes and of the same value as a birth certificate. It is furnished by the steel mills to the boilermaker and passed along by the latter upon request of the customer, which is seldom for low pressure boilers, and one out of five for high pressure boilers.

The necessity for retubing a boiler depends much upon the use and abuse the tubes receive. Bad water can soon perforate them unless water treatment is maintained. Water treatment, once or twice a year, ordinarily sufficient, is futile when frequent make-up of water is required, as with too much boiler flushing, return leakage, or hissing air valves.

In my home the tubes in the steam boiler, now 15 years old, were renewed within the first two years, then there was a lapse of 11 years and again they were renewed. I learned that corrosive air bubbles must be wiped off where they collect along the top of the tubes, the point where tubes corrode. To wipe them off, the water must be kept active by maintaining a fairly high water line and by continuing boiler operation of the heating boiler for hot water supply in the summer months.

Separate heating of hot water supply by a pot stove using wood or any fuel available was a necessity when oil supplies were doled out in limited quantities during the war. The tubes of the heating boiler then suffered, as the boiler was less frequently operated and remained idle during summer months. Furthermore, the 15-year-old air valves in my home frankly need renewal. A number hiss, and where boiler water make-up was required but once a month, it is now once a day.

NEWS OF EQUIPMENT AND MATERIALS

Use the prepaid postcard opposite Page 102 for securing additional information on items described in this department.

Two Tankless Water Heaters

Addition of two tankless water heaters to its line has been made by Bell & Gossett Co., Morton Grove, Ill. They are available as a standard unit without the jacket or as a deluxe unit with a well insulated metal jacket (illustrated) and are constructed with a cast iron shell and a spiral copper tube bundle.

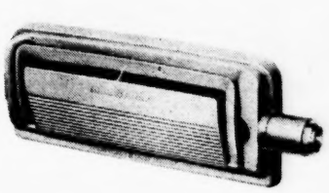
Both standard and deluxe models are made in three sizes, 12, 14, and 16, with capacities of 210, 240, and 300 gallons of water per hour, respectively, heated from 40 to 140 degrees when the boiler water is 180 degrees or higher capacities with 200 degrees boiler water.

Prior to this the company has made a standard tankless heater in two sizes with capacities of 360 and 480 gallons of water per hour. All are designed for basements lacking space for storage tanks or where service water conditions would make it necessary to use expensive copper or other non-ferrous tanks. The tankless heater likewise saves the cost of a storage tank pump and stand. Use of a Watermixer is recommended on all tankless heater installations.

For more information, circle on Inquiry Card, **Item 1**

Register Has Automatic Control

An individually temperature-controlled register for warm air furnaces has been introduced by General Electric Co., Bloomfield, N. J., under the name of Automatic Air Wall registers. The heating plant itself is under the control of the conventional house thermostat, but the temperature in individual rooms can be adjusted by the Thermo-dial on each register.



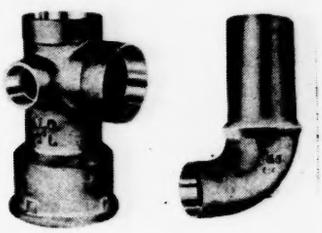
These registers keep each room at the temperature for which it is set by modulating the dampers, opening to just the right amount to admit the proper quantity of warm air from the furnace. In addition to setting for temperature control, the dial may also be set to stay fully open or closed.

With these registers, when the room temperature reaches the temperature level desired, the thermostat control moves the register damper to closed position. When more heat is desired in a room, the dial can be set at a higher temperature and a greater amount of heat will be admitted to the room. When heat from the furnace is needed fast, such as in the morning after a night period of lower thermostat setting, the register dampers are automatically opened to bring room to desired temperature setting quickly.

For more information, circle on Inquiry Card, **Item 2**

Combination Drain Fittings

Two new combination drainage fittings have been introduced by H & G Plumbing Products, Inc., Port Washington, N. Y. Features are said to be the cutting of installation time and elimination of extra work because they reduce two operations to one.



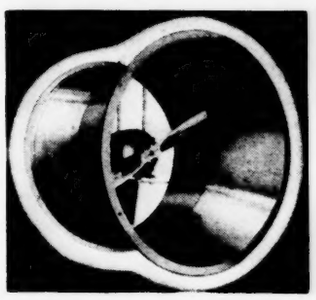
The one fitting is a side outlet tee combined with a soil pipe ferrule (left view). This is constructed of high quality cast bronze and cannot leak. It is made with a side outlet on either side for right or left hand.

The second fitting is a bronze-lead combination water closet bend with an approved wiped joint (right). The manufacturer claims that wherever lead pipe is used for closet connections, this fitting is the only one that can be used on a copper bronze soil, waste and vent system. It comes in 4-inch lead and 2-inch bronze. The lead is made in varied lengths to meet exact requirements.

For more information, circle on Inquiry Card, **Item 3**

Reversible Fan for Industry

A fully reversible fan has been made available by Hartzell Propeller Fan Co., Piqua, Ohio. The fan has an air delivery of approximately 20,000 cfm at free air by a 36-inch single-blade model equipped with a 2 hp motor. Air delivery is identical when the fan is reversed. This alternate-direction efficiency is accomplished by a specially designed propeller.



An example of industrial procedure which requires reversibility of air flow without loss of efficiency is the lumber drying process. One-way circulation of heated air sometimes causes case-hardening at one end of a kiln and incomplete drying at the other. The reversible fan (which may be periodically reversed either manually or automatically) provides uniform drying in the kiln. This new fan also fulfills other industrial needs where the air must be efficiently circulated in two directions.

For more information, circle on Inquiry Card, **Item 4**

Clip Cuts Duct Insulating Cost

Simple, low-cost, one-man installation of duct insulation materials is possible through the use of Quick-Clips, introduced by Nelson Stud Welding Division of Morton Gregory Corp., Lorain, Ohio. The formed-wire clip is used to install insulation material around ductwork, thus eliminating adhesives, expensive clips stuck to the duct, or sheet metal screws and caps.

Any type of board insulation may be used. The side pieces are cut to fit the duct, while the top and bottom pieces overlap. While the side piece is held in position, one end of the clip is placed over the edge of the top piece. The fastener is then pulled down and impales the side piece, holding it is place. The procedure is reversed for securing the bottom piece. This new method eliminates metal-to-metal contact, preventing heat transfer and resultant condensation, and also minimizes calking work as a tight butt joint is obtained.

For more information, circle on Inquiry Card, **Item 5**

Sheet Metal Pipe Support

The Jiffy Johnson pipe support has been introduced by Johnson Heating Co., El Monte, Calif., for supporting sheet metal pipe.

The support is quite flexible, as can be judged by the illustration, and this flexibility provides for support of pipes at all angles in both a vertical and horizontal plane. Distance between supported pipe and joists is varied by spacing of nail-pointed cross legs.

The hanger, consequently, provides a simplified means of supporting metal pipe without the use of wood bracing and wire fastenings, and can be used as a hanger or as a support on diagonals or straight runs.

The hangers are made in three sizes, one for pipes up to 5 inches in diameter, a second for pipe from 6 to 8 inches, and a third for pipes from 9 to 14 inches.

For more information, circle on Inquiry Card, **Item 6**

Hot Water Converters

A new line of hot water converters is announced by Doyle & Roth Mfg. Co., Brooklyn, N. Y. These units are designed to supply hot water to radiant heating panels or hot water systems. The water for heating flows through the tubes with steam in the shell. Live or exhaust steam is employed as the heating medium. They are recommended for hotels, schools, public buildings, industrial plants, and housing developments.

For more information, circle on Inquiry Card, **Item 7**

Hanger Fits Concrete Joist

The Loadgrip clamp hanger has been placed on the market by United Industries, Madison, Wis., for supporting pipe, conduits, and equipment from the underside of standard pre-cast concrete joists. This hanger, currently manufactured for use on a standard 8-inch precast concrete joist, features a strong gripping action with the load, hand installation, hand removal, ease of relocation, a close fit to bottom of joist, and attachment holes in each of the three horizontally protruding legs.

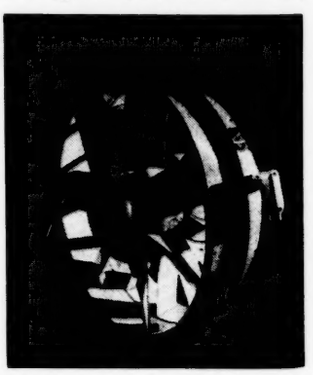
It is designed to fit normally oversize or undersize joist widths and supports its own weight when placed on the joist with no load attached. The hanger is made of 3/16 inch thick, cold-rolled steel material and is heavily galvanized to resist rust.

For more information, circle on Inquiry Card, **Item 8**

Axial Flow Pressure Blower

The Class 2000 pressure blower has been introduced by The Moore Co., Marceline, Mo. It is a low speed, direct-driven, separately ventilated, and corrosion-resistant axial flow fan.

Fan is available in two size ranges. Series 16 units, with a 16-inch hub with outside diameters of from 3 ft to 5 ft. Series 24 units have 24-inch hub and diameters from 4 ft to 8 ft.



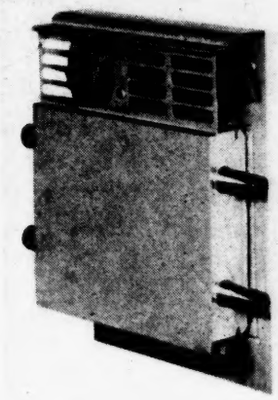
The blower is available to fit the job. The units are tailor assembled for any one of an infinite number of performance requirements. From standard parts, a unit of given diameter with from two to nine blades, set to the proper angle, may be provided. In addition, guide vanes are set to the proper angle, providing axial discharge. The spherical hub and housing and spherical rings allow these benefits without extra cost.

Units may be furnished in carbon steel, Monel metal, stainless steel, or any other workable metal available in sheet form. Belt drive units are available for special applications where direct drive units might not be suitable.

For more information, circle on Inquiry Card, **Item 9**

Baseboard Cover Has Damper

The steel cover of the Kritzer standard baseboard has been redesigned to increase convection output, and a new damper for controlling this warm air is now supplied with the baseboard when specified, according to the manufacturer, Kritzer Radiant Coils Inc., Chicago 25, Ill. A control knob, designated as an "operator" (as shown in photo) is installed in damper-equipped baseboards to regulate dampers up to 10 ft long in the simplest, easiest way.



The extra warm-air output from the baseboard is due to the added chimney effect achieved by recently redesigned louvers. The fin-tube coil enclosed within the baseboard is composed of aluminum fins mechanically bonded on two copper tubes through which hot water is piped. Cover plate snaps in place; no screws or fastenings are required.

The baseboard harmonizes with any decorative scheme, and is supplied in handy 10-ft sections; it is easily cut to fit on the job, and is simple to install.

For more information, circle on Inquiry Card, **Item 10**

Packaged Water Chiller

The Acme Flow-Cold liquid chiller, a self-contained unit designed to produce and circulate chilled water for air conditioning systems, drinking water systems, and process cooling, is being marketed by Acme Industries, Inc., Jackson, Mich.

These packaged units are completely tested and checked before leaving the factory. Package includes starters, internal wiring, circulator, and high-low pressure control which cuts out at 30 lb at the low side and restarts at 46 to 50 lb. High side is set at 179 to 185 lb cutout, restart at 133 to 140 lb. Refrigerant is Freon.

For more information, circle on Inquiry Card, **Item 11**

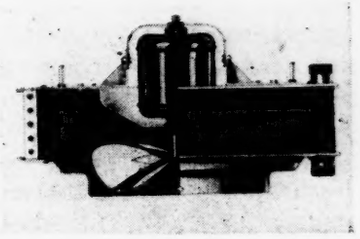
Floatless Level Control

The Floatless level control has been introduced by Leslie Co., Lyndhurst, N. J. This control consists of a control pilot, designed for multi-medium actuation by either air or water, which responds to changes in the level of a liquid and controls a regulating valve in the liquid line to correct for level changes. Necessity for floats, float cages, or chambers, stuffing boxes, etc. has been eliminated. The control has only five moving parts under pressure. In this manner the various limitations of stuffing boxes, bellows, torque tubes, and thermo elements are overcome. Also, there are no mechanical linkages inside or outside the tank or vessel containing the liquid. Installation can be made on a convenient control panel instead of at liquid level.

For more information, circle on Inquiry Card, **Item 12**

Projection Unit Heaters

A new series of projection unit heaters has been announced by The Trane Co., La Crosse, Wis. It includes a new model, 275-P, which has a 35-inch fan and 451,000 Btu capacity. Capacities for other models range from 55,300 Btu for No. 100P to 550,000 Btu for No. 300P.



Over-all dimensions remain the same, but an attractive offset roll has been added to the bottom to give added rigidity and improved appearance. Only the motor and housing brackets protrude beyond the top of the unit. All bracing is done beneath the top plate for added strength.

It is possible to remove the motor either through the top of the unit or through the discharge orifices on larger models.

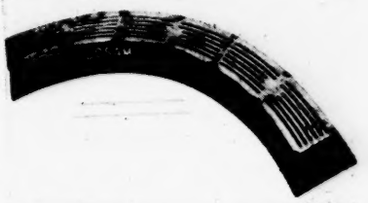
A new hydraulically expanded coil is used. The tubes are expanded under pressure of 3000 lb per sq in. Capacities generally remain in the range of the original model. The unit is easier to clean and maintain.

The Model P Heater has a companion diffuser which makes it possible to send air in an almost infinite variety of patterns from the ceiling.

For more information, circle on Inquiry Card, **Item 13**

Drain for Revolving Doors

A new drain recently developed for the United Nations project in New York City is the series 0370 revolving door drain made by Josam Mfg. Co., Cleveland, Ohio. This drain is designed for installation at the entrance of revolving doors to drain away excess water due to heavy rains or snowfalls.



The drain body and 90-degree frame is made of cast iron with a 6-inch non-skid Nicolun grate fastened to the frame by screws. The drain body has a flange which can be used as an anchor in construction or for attaching water-proofing.

For more information, circle on Inquiry Card, **Item 14**

High Pressure Steam Traps

New, inexpensive small forged steel steam traps have been developed by the V. D. Anderson Co., Cleveland, Ohio, for high pressure, superheated steam service. These traps are suitable for steam pressures up to 500 lb with 800 deg total temperature and have ½ or ¾ inch pipe connections.

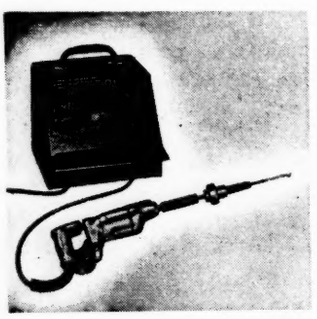
These units have unusual safety features, as the head and body are of forged steel to withstand shock and explosions. Internal parts are of stainless steel with valve and seat made of Anderloy, an alloy developed for steam service. These small traps have a recessed gasket to prevent blowing out.

The traps are made in two principal types. No. 340 is installed straight-in-line or as an elbow eliminating nipples and fittings, saving approximately one hour installation time. The other type, No. 60, is designed with the inlet in the bottom and the outlet connection in the top for a vertical installation. Both types have guided bucket for positive valve closing and minimum of moving parts.

For more information, circle on Inquiry Card, **Item 15**

Tube Rolling Control

Announcement of a simplified tube rolling control has been made by Crane Packing Co., Chicago, Ill. This electrically operated control is low in initial cost, and because of the elimination of electronic tubes and large numbers of working parts, it practically does away with maintenance. It can be used for rolling of both ferrous and non-ferrous condenser and heat exchanger tubing.



Marketed under the trade name, John Crane Control, the unit is a precision instrument designed for heavy duty service. It has only two electrical working parts, shock-proof mounted and enclosed in a rugged aluminum cabinet. The electrical parts form a separate, easily removed unit. The control unit is light in weight, and is easily moved on the job.

Operation is simple. Dial settings on the control panel are calibrated over a wide range of sizes and gages, in both ferrous and non-ferrous tubing. The expanding gun is plugged into the control unit, and the dial setting is made. Slight pressure on the handle of the gun engages the control. As soon as the tube is rolled to exactly the proper degree, the control cuts off the motor.

In tubes rolled by this method, over-expanding of tube ends is eliminated, with consequent reduction of cold worked stresses, tube-end thinning and early tube failures. Under-expanding, too, is prevented, assuring tight joints on the initial test and during operation of the condensing unit.

For more information, circle on Inquiry Card, **Item 16**

Chemical Process Valves

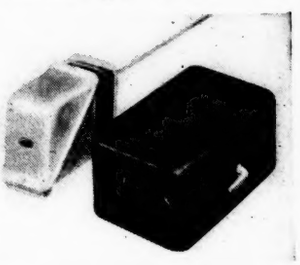
One of the common but serious complaints against chemical process valves is the corrosion and binding of metal spindle threads. To eliminate this complaint, Karbate impervious graphite globe valves, manufactured by National Carbon Division, Union Carbide and Carbon Corp., New York 17, N. Y., have self-lubricating, corrosion-resistant threads on the bonnet and spindle. Users without previous experience with impervious graphite valves are often skeptical of the ability of the spindle threads to stand up under continued use.

The accompanying photograph is an untouched picture of the spindle from a 1-inch valve that has been in continuous service for over two years. This valve was used to fill carboys from a sulphuric acid storage tank and was therefore subjected to complete opening and closing a number of times each day. The spindle threads show a very slight rounding, but are still in excellent condition. The disc on the spindle has worn exactly as expected and continues to reseat itself.

For more information, circle on Inquiry Card, **Item 17**

Gas Burner Safety Control

A new Fireye system providing complete flame failure protection and programming for industrial and commercial automatic gas burners is announced by Combustion Control Corp., Cambridge, Mass. The equipment includes programming control type 24PJ8 and electronic flame rod type 45JQ1.



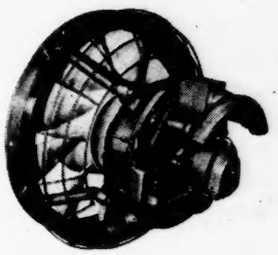
This control automatically starts and programs the burner in operation. It programs the sequence of purging blower motor and ignition fuel valve opening, and post-ignition timing. Fuel valve delay and post-ignition periods can be easily set upon installation, and a calibrated dial clearly indicates the timing adjustment in seconds.

The flame rod will not allow the main gas valve to open until the pilot flame is established and detected. Once the main flame is established, the flame rod feels the presence of the flame and, if the flame fails, signals the control which instantly cuts off fuel. The control can be wired to operate an alarm upon flame failure.

For more information, circle on Inquiry Card, **Item 18**

Steam-Turbine-Driven Blowers

A line of turbine blowers with all-steel turbines, suitable for steam conditions up to 600 lb per sq in. and 750 deg total temperature, is announced by L. J. Wing Mfg. Co., Linden, N. J.



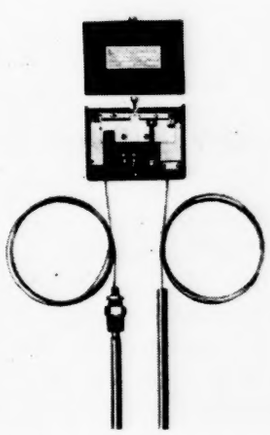
While retaining the basic advantages of compactness and light weight, rugged and dependable design, ability to be installed in most any location, and low initial and installation cost, these blowers have been modernized with fan impellers of airfoil design and streamlined air entry for high efficiency, and quiet operation. No water cooling required, since bearings and lubrication system are automatically air cooled.

For oil burner applications they can be bolted directly to the front windbox without additional supports. Also can be furnished for vertical down discharge, or for cementing into boiler brickwork. They are ideal for capacity regulation through speed variation. Can also be furnished with voltrol vanes and constant speed governors for damper regulation. Capacities to 70,000 cfm or static pressures to 20 inches of water.

For more information, circle on Inquiry Card, **Item 19**

Economy Hot Water Control

The Type AO outdoor compensating control for hot water and radiant heating systems is announced by Sarcotherm Controls, Inc., New York, N. Y. The control has been developed for dwellings and other applications where desired economy and first cost have prohibited the installation of more elaborate and costly instruments.



This control is recommended for use on automatically fired hot water and radiant heating applications where indirect domestic hot water is not drawn from the same heating source. It may be used to control the operation of an oil burner, automatic stoker, or a gas, water, or steam valve. It consists of a switch mechanism mounted in a metal case and controlled by a thermostatic bulb located outdoors, and a water bulb located in the hot water supply to the heating system. This control mechanism varies the circulating water temperature in the system in accordance with outdoor temperature changes by controlling the operation of the oil burner relay, or the gas valve, water valve, or stoker timer.

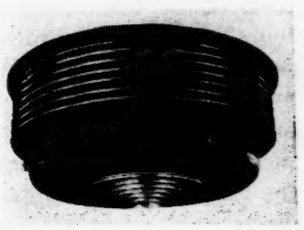
The control can be adapted to operate a completely automatic centralized program control system for small apartments, schools and offices, provided domestic hot water is not drawn from the same boiler. However, large installations will probably require the use of three-way valves where the water is continuously blended.

The control is available in two models, one with a single pole, single throw switch, the other with a single pole, double throw switch. Application data for a direct-fired boiler, an indirect-fired system, zone control system and centralized program control system are included in Bulletin ST600, available on request.

For more information, circle on Inquiry Card, **Item 20**

Gas Heater Has Ample Headroom

A gas-fired overhead forced convection heater, the Three-Sixty, is introduced by Norman Products Co., Columbus, Ohio. It is intended for stores, shops, gas stations and similar applications.



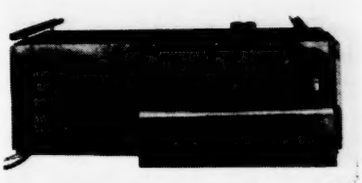
The heater distributes warm air in a 360-degree radius and is designed for on-the-ceiling installation. Its shallow depth permits ample headroom in rooms with the lowest of ceilings. Forced exhaust of combustion products eliminates venting problems and air contamination.

A low velocity impeller distributes warm air through seven diffuser rings across the ceiling in a 360-degree radius, and down all four walls, blanketing the entire floor area on its way back to the return air intake in the bottom of the unit. Heater is rated at 100,000 Btu per hour; other sizes will be available soon.

For more information, circle on Inquiry Card, **Item 21**

Horizontal Gas-Fired Furnace

A horizontal gas-fired warm air furnace has been announced by United States Radiator Corp., Detroit, Mich. It is a compact package unit, shipped assembled, with all controls and accessories mounted and wired, including thermostat and thermostat wires.



An efficient combustion chamber and burner, coupled with quality gas controls, yield high fuel efficiencies. A quiet blower insures positive circulation of clean, filtered air.

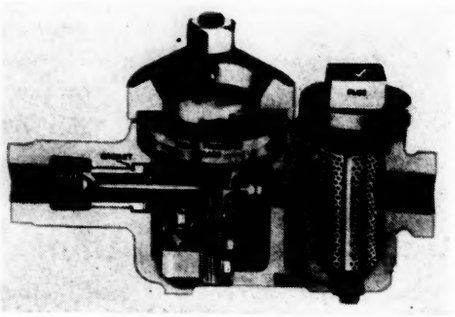
The furnace is made in three models rated at 60,000, 80,000, and 100,000 Btu per hour input, and may be used with natural, manufactured or L.P. gases.

Installation may be made under the floor, in an attic, in an ordinary basement, or suspended in a utility or furnace room.

For more information, circle on Inquiry Card, **Item 22**

Steam Trap Has Glass Port

The Velan steam trap is now being produced in this country by Velan Engineering Co., Jersey City 2, N. J. This trap, which is of the bimetallic type, is said to do the job of three valves. It includes a strainer and an observation glass, and is available in one size, with ½ or ¾ inch ends which can be used for piping from ½ to 2 inches.



The number of bimetallic plates determine the maximum pressure allowed.

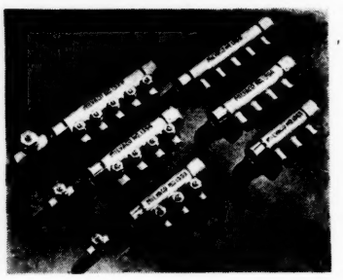
In operation, when starting up, the valve is completely open, with a blast discharge of large amounts of air and water due to oversize orifice. Then incoming steam increases temperature of the bimetal element and develops the force which overcomes the pressure acting on the valve and closes the trap. As steam condenses, water enters and fills the body. The opening of the valve is effected in two steps without registering any pressure drop in the line. The first impulse is given by the cooler condensate. Low pressure is acting on the smaller diameter. When the flow is released, pressure acts on larger valve surface, pressure increases and overcomes thermal pull for full capacity. In the return line, sudden pressure drops, rapid fluctuation, or discharging to overhead lines causes back flow, and the valve closes automatically as a check valve and prevents back flow.

Simplicity of the trap, and the fact that it includes an observation port as well as a strainer, reduce the number of parts which is necessary to stock, and this, with the visual control of the function are among the advantages of the device.

For more information, circle on Inquiry Card, **Item 23**

Add 5-Valve Manifold to Line

In answer to demands, Milwaukee Valve Co., Milwaukee, Wis., has enlarged its line of bronze supply line manifold headers and bronze balancing valve manifolds with the introduction of five-valve units to supplement its four and three manifold units, and single control balancing valve already on the market. They are designed for radiant panel heating systems. The five-valve manifolds add flexibility to an already proven line and will accommodate virtually any number of circuits. Various manifold combinations are easily made.



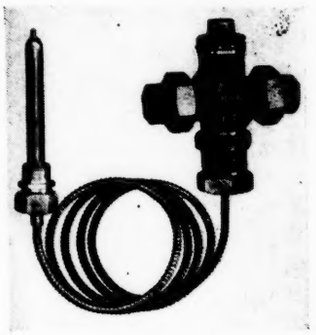
These manifolds not only eliminate the need of extra fittings and joints, but also reduce soldering and sweating time and cut installation costs. The simple connecting of a four and five series unit results in a nine valve or outlet manifold and cuts out eight time-consuming joining operations as well as the cost of extra fittings.

Constructed of top-grade steam bronze, the three, four, and five valve manifolds and the three, four and five outlet headers are available in two sizes: 1¼ x ⅜ inch, and 1¼ x ½ inch. The single units come in ⅜, ½, and ¾ inch sizes.

For more information, circle on Inquiry Card, **Item 24**

Temperature Control Valve

Applicable to any process involving heating or cooling by means of water, oil, steam or other fluids, the improved Sterlco series 150E temperature control valve is announced by Industrial Control Div., Sterling, Inc., Milwaukee 12, Wis. It is an entirely self-contained unit consisting of a compact, sturdy bellows-packed valve with stainless steel trim and monel bellows, a capillary tube, and a thermostat bulb.



Flow through the valve is automatically modulated in accordance with the temperature at the bulb. Constant temperature, adjustable over a wide range, can be maintained at all times. It is built in two styles: direct-acting, with which the valve closes as bulb temperature rises, for heating; and reverse-acting, where the valve opens as bulb temperature rises, for cooling.

The valve is available in ½, ¾, and 1 inch sizes, with a maximum pressure rating of 125 pounds per square inch.

For more information, circle on Inquiry Card, **Item 25**

Colored Wire Markers

The current shortage of colored wire has created problems for the construction industries. For example, instruction manuals and wiring diagrams show colored wire coding. If single colored wire is used, confusion is created in the field.

An inexpensive and satisfactory method of solving this problem has been developed by W. H. Brady Co., Chippewa Falls, Wis. Wires can now be color coded by applying Quik-Label colored wire markers. These markers are made of silicone treated cotton cloth which has a pressure sensitive adhesive backing. They stick permanently to wire without moistening and are simple to apply. The markers make it possible to buy wire in various sizes, but in only one color. This simplifies the problem of keeping large inventories of multi-colored wire in stock. They come in 14 standard NEMA colors.

For more information, circle on Inquiry Card, **Item 26**

DEGREE-DAYS FOR SEPTEMBER, 1950

(A) Airport readings; (C) City office readings; (O) Readings at a point on outskirts of city.

HEATING AND VENTILATING'S 23rd Year of Publication of Monthly Degree-Day Data

City	September			Cumulative, September 1 to September 30			Heating Season[1]
	1950	1949	Normal	1950	1949	Normal	Normal
Abilene, Texas (A)	0	6	0	0	6	0	2061
Albany, New York (A)	215	208	72	215	208	72	6580
Albuquerque, New Mexico (A)	27	6	0	27	6	0	4298
Alpena, Michigan (C)	268	260	222	268	260	222	8299*
Anaconda, Montana (C)	399	303	335	399	303	335	8357**
Asheville, North Carolina (C)	54	100	0	54	100	0	4232
Atlanta, Georgia (C)	14	23	0	14	23	0	2890
Atlantic City, New Jersey (C)	77	57	0	77	57	0	5176
Augusta, Georgia (A)	15	4	0	15	4	0	2161
Baker, Oregon (C)	236	164	258	236	164	258	7163
Baltimore, Maryland (C)	61	47	0	61	47	0	4533
Billings, Montana (A)	286	203	189	286	203	189	7119
Binghamton, New York (C)	199	200	108	199	200	108	6808
Birmingham, Alabama (A)	1	25	0	1	25	0	2352
Bismarck, North Dakota (A)	232	272	222	232	272	222	9192
Block Island, Rhode Island (C)	125	78	0	125	78	0	5788
Boise, Idaho (A)	142	90	102	142	90	102	5552
Boston, Massachusetts (A)	149	105	48	149	105	48	6045
Boseman, Montana (C)	460	282	336	460	282	336	8521**
Buffalo, New York (A)	155	206	75	155	206	75	6822
Burlington, Iowa (A)	79	182	(a)	79	182	(a)	(a)
Burlington, Vermont (A)	294	197	144	294	197	144	7514
Butte, Montana (C)	447	326	344	447	326	344	8235**
Cairo, Illinois (C)	21	53	0	21	53	0	3909
Canton, New York (C)	286	237	189	286	237	189	8020
Charleston, South Carolina (C)	2	0	0	2	0	0	1769
Charlotte, North Carolina (C)	38	28	0	38	28	0	3120
Chattanooga, Tennessee (A)	11	36	0	11	36	0	3118
Cheyenne, Wyoming (A)	300	218	240	300	218	240	7466
Chicago, Illinois (C)	41	126	76	41	126	76	6077
Cincinnati, Ohio (C)	46	86	0	46	86	0	4684
Cleveland, Ohio (A)	77	180	27	77	180	27	6155
Columbia, Missouri (C)	43	112	0	43	112	0	4922
Columbia, South Carolina (C)	21	13	0	21	13	0	2364
Columbus, Ohio (C)	100	130	0	100	130	0	5398
Concord, New Hampshire (A)	287	234	168	287	234	168	7353
Concordia, Kansas (C)	50	96	0	50	96	0	5315
Dallas, Texas (A)	0	5	0	0	5	0	2256
Davenport, Iowa (C)	55	152	0	55	152	0	6289
Dayton, Ohio (A)	94	182	0	94	182	0	5264
Deer Lodge, Montana (C)	417	310	399	417	310	399	8672**
Denver, Colorado (C)	169	76	72	169	76	72	5874
Des Moines, Iowa (C)	54	136	0	54	136	0	6384
Detroit, Michigan (A)	106	182	42	106	182	42	6490
Devils Lake, North Dakota (C)	251	301	276	251	301	276	9970
Dodge City, Kansas (A)	53	69	0	53	69	0	5035
Dubuque, Iowa (C)	75	190	36	75	190	36	6790
Duluth, Minnesota (C)	254	315	270	254	315	270	9483
Eastport, Maine (C)	334	238	276	334	238	276	8520**
Elkins, West Virginia (A)	165	220	63	165	220	63	5697
El Paso, Texas (A)	0	0	0	0	0	0	2428
Ely, Nevada (A)	319	183	(a)	319	183	(a)	(a)
Erie, Pennsylvania (C)	101	147	36	101	147	36	6273
Escanaba, Michigan (C)	257	305	243	257	305	243	8771
Evansville, Indiana (A)	43	112	0	43	112	0	4244
Fort Smith, Arkansas (A)	5	35	0	5	35	0	3147
Fort Wayne, Indiana (A)	111	202	0	111	202	0	5925
Fort Worth, Texas (A)	0	6	0	0	6	0	2148
Fresno, California (A)	10	1	0	10	1	0	2334
Galveston, Texas (C)	0	0	0	0	0	0	1016
Grand Junction, Colorado (A)	69	31	0	69	31	0	5548
Grand Rapids, Michigan (A)	110	184	57	110	184	57	6535
Green Bay, Wisconsin (C)	212	276	132	212	276	132	7825
Greensboro, North Carolina (A)	62	52	0	62	52	0	3529
Greenville, South Carolina (A)	31	41	0	31	41	0	3380
Harrisburg, Pennsylvania (A)	117	116	0	117	116	0	5375
Hartford, Connecticut (A)	183	132	48	183	132	48	6036
Hatteras, North Carolina (C)	8	1	0	8	1	0	2571
Havre, Montana (C)	282	211	270	282	211	270	8700
Helena, Montana (A)	360	301	251	360	301	251	7894**
Houston, Texas (C)	0	0	0	0	0	0	1157
Huron, South Dakota (A)	146	215	123	146	215	123	8004
Indianapolis, Indiana (A)	78	155	0	78	155	0	5298
Jackson, Mississippi (A)	0	10	(a)	0	10	(a)	(a)
Kansas City, Missouri (A)	34	79	0	34	79	0	4956
Knoxville, Tennessee (A)	27	50	0	27	50	0	3670
La Crosse, Wisconsin (A)	138	247	96	138	247	96	7322
Lander, Wyoming (A)	355	198	276	355	198	276	7947

(a) Data not available.

[1]Figures in this column are normal totals for a complete heating season, September to June, inclusive.

Figures in this table, with seven exceptions, based on local weather bureau reports. Exceptions are Utica and Lewiston, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y., and Norman E. Ross, Bursar, Bates College, Lewiston, Me., respectively; Anaconda, Bozeman, Butte, Deer Lodge and Livingston, Mont., through the courtesy of the Montana Power Company.

[Table concluded on page 1041

Degree-Days for September, 1950 (Concluded)

(A) Airport readings; (C) City office readings; (O) Readings at a point on outskirts of city.

HEATING AND VENTILATING's 23rd Year of Publication of Monthly Degree-Day Data

City	September			Cumulative, September 1 to September 30			Heating Season[1]
	1950	1949	Normal	1950	1949	Normal	Normal
Lansing, Michigan (A)	154	247	114	154	247	114	7048
Lewiston, Maine (O)	300	201	165	300	201	165	7707
Lincoln, Nebraska (C)	64	122	0	64	122	0	5999
Little Rock, Arkansas (A)	14	27	0	14	27	0	2811
Livingston, Montana (C)	360	235	227	360	235	227	7245**
Los Angeles, California (C)	0	0	0	0	0	0	1504
Louisville, Kentucky (A)	40	93	0	40	93	0	4180
Lynchburg, Virginia (A)	75	85	0	75	85	0	3980
Macon, Georgia (A)	5	5	0	5	5	0	2201
Madison, Wisconsin (C)	116	220	87	116	220	87	7429
Marquette, Michigan (C)	249	299	225	249	299	225	8693*
Memphis, Tennessee (A)	10	29	0	10	29	0	2950
Meridian, Mississippi (A)	2	12	0	2	12	0	2160
Milwaukee, Wisconsin (A)	136	203	84	136	203	84	7245
Minneapolis, Minnesota (A)	100	211	93	100	211	93	7850
Montgomery, Alabama (A)	1	5	0	1	5	0	1884
Nantucket, Massachusetts (A)	174	102	63	174	102	63	5957
Nashville, Tennessee (A)	19	43	0	19	43	0	3507
New Haven, Connecticut (A)	148	108	39	148	108	39	5895
New Orleans, Louisiana (C)	0	0	0	0	0	0	1024
New York, N. Y. (C)	87	53	50	87	53	50	5274***
Nome, Alaska (A)	Degree-Days for June, 1950 (not previously published) are 700. Total for season (Sept. 1, 1949 to June 30, 1950) is 12,628.						
Norfolk, Virginia (C)	26	12	0	26	12	0	3350
North Head, Washington (C)	284	201	255	284	201	255	5452**
North Platte, Nebraska (A)	133	156	42	133	156	42	6366
Oakland, California (A)	59	38	90	59	38	90	3143**
Oklahoma City, Oklahoma (C)	3	38	105	3	38	105	3613
Omaha, Nebraska (A)	77	137	0	77	137	0	6131
Oswego, New York (C)	198	172	114	198	172	114	7088
Parkersburg, W. Virginia (C)	73	127	0	73	127	0	4775
Peoria, Illinois (A)	62	168	3	62	168	3	6109
Philadelphia, Pennsylvania (C)	85	46	36	85	46	36	4737***
Phoenix, Arizona (C)	0	0	0	0	0	0	1405
Pittsburgh, Pennsylvania (C)	78	120	0	78	120	0	5235
Pocatello, Idaho (A)	240	130	156	240	130	156	6655
Portland, Maine (A)	312	239	162	312	239	162	7218
Portland, Oregon (C)	90	59	105	90	59	105	4469
Providence, Rhode Island (C)	0	100	63	0	100	63	6015
Pueblo, Colorado (A)	87	43	6	87	43	6	5514
Raleigh, North Carolina (C)	46	26	0	46	26	0	3234
Rapid City, South Dakota (A)	233	184	144	233	184	144	7118
Reading, Pennsylvania (C)	103	93	0	103	93	0	5389
Red Bluff, California (A)	8	2	(a)	8	2	(a)	(a)
Reno, Nevada (A)	201	139	144	201	139	144	5892
Richmond, Virginia (C)	60	36	0	60	36	0	3695
Rochester, New York (A)	169	209	72	169	209	72	6732
Roseburg, Oregon (C)	(a)	51	111	(a)	51	111	4428
Roswell, New Mexico (A)	1	7	0	1	7	0	3484
Sacramento, California (C)	8	3	0	8	3	0	2653
St. Joseph, Missouri (A)	53	106	0	53	106	0	5161
St. Louis, Missouri (C)	25	70	0	25	70	0	4585
Salt Lake City, Utah (A)	135	58	18	135	58	18	5555
San Antonio, Texas (A)	0	0	0	0	0	0	1202
San Diego, California (A)	0	1	0	0	1	0	1645
Sandusky, Ohio (C)	8	3	0	8	3	0	6208
San Francisco, California (C)	122	106	114	122	106	114	3264**
Sault Ste. Marie, Michigan (A)	328	355	276	328	355	276	9285**
Savannah, Georgia (A)	1	1	0	1	1	0	1490
Scranton, Pennsylvania (C)	169	166	60	169	166	60	6129
Seattle, Washington (C)	128	112	186	128	112	186	4934**
Sheridan, Wyoming (A)	306	233	264	306	233	264	8008
Shreveport, Louisiana (A)	2	9	0	2	9	0	1938
Sioux City, Iowa (A)	96	180	33	96	180	33	6898
Spokane, Washington (A)	144	155	192	144	155	192	6355
Springfield, Illinois (C)	41	96	0	41	96	0	5373
Springfield, Missouri (A)	61	106	0	61	106	0	4428
Syracuse, New York (A)	202	180	96	202	180	96	6893
Tacoma, Washington (C)	171	156	207	171	156	207	5181**
Terre Haute, Indiana (A)	64	138	0	64	138	0	4872
Toledo, Ohio (A)	105	203	9	105	203	9	6077
Topeka, Kansas (C)	32	79	0	32	79	0	4969
Trenton, New Jersey (C)	118	84	0	118	84	0	4933
Utica, New York (O)	222	146	182	222	146	182	6796
Valentine, Nebraska (C)	182	190	93	182	190	93	7039
Walla Walla, Washington (C)	76	64	30	76	64	30	4808
Washington, D. C. (C)	55	55	0	55	55	0	4626
Wichita, Kansas (A)	28	59	0	28	59	0	4673
Williston, North Dakota (C)	274	277	270	274	277	270	9323
Winnemucca, Nevada (C)	227	126	192	227	126	192	6427**
Yakima, Washington (A)	131	127	120	131	127	120	5599

(a) Data not available.

*Includes August.
**Includes July and August.
***New 48-year normal covering 1898 to 1946.

[1]Figures in this column are normal totals for a complete heating season, September to June, inclusive.

NEWS OF THE MONTH

DR. WILLIS H. CARRIER

air conditioning pioneer, dies at 73.

Dr. Willis H. Carrier earned an undisputed reputation during his lifetime of being the founder of the air conditioning industry. He died October 7 at 73.

For many years chairman of the board of Carrier Corporation, and later chairman emeritus, Dr. Carrier was active as a scientist and engineer in the air conditioning and refrigeration field for half a century. During the last few years of his career, however, he devoted himself principally to writing and to advising the scores of skilled engineers he had trained to carry on his work.

He was a prominent member of the American Society of Mechanical Engineers and was awarded the gold achievement medal of that organization. He served as president of both the American Society of Heating and Ventilating Engineers and the American Society of Refrigerating Engineers and was awarded two other gold medals for his pioneering work in the exact control of temperatures and humidity in enclosed areas.

He was the American representative at the World Engineering Congress in Japan in 1930, and in 1940 was selected as a "Modern Pioneer of American Invention" by the National Association of Manufacturers. In 1947 he was one of three Americans invited to address the centenary celebration of Britain's Institution of Mechanical Engineers.

Dr. Carrier was interested primarily in the engineering, development and research phases of the industry he founded, and in training younger engineers. He did not choose to devote any large part of his time to the business operations of Carrier Corporation.

• **INVENTIONS.**—Dr. Carrier developed and installed the world's first scientific air conditioning system in 1902. As as project engineer for the Buffalo Forge Company, Buffalo, New York, he was given the job of solving the temperature and humidity problem that had interfered with the summer operations of the Sackett-Wilhelms Lithographing and Publishing Company of Brooklyn, New York.

The equipment he devised for this first installation was so cumbersome and complicated that he immediately started a search for a better method. The idea that led to a solution came to him one autumn night when a cold, heavy fog enveloped the station in which he was waiting for a train. He figured that if he could produce an artificial fog in a stream of air and control the temperature of the fog, he could "wring" the water from the air at will. By 1905 Dr. Carrier was able to announce the invention of the spray-type air conditioner. A number of pioneering installations followed—the first in a glue factory that needed drier air and in a textile mill that had to have exact control of humidity. This system was capable of heating, cooling, humidifying and dehumidifying, and with a number of refinements it still stands today as one of the most efficient types of apparatus available for air treatment. The whole vast science of air conditioning actually started with this spray-type air conditioner.

Dr. Willis H. Carrier, a few years ago, describing the Carrier Conduit System to architects and engineers.

In writing to a friend about this pioneer work, Dr. Carrier told his story about the idea that came to him in an autumn fog and added:

"This is the gist of the story. In the development I borrowed and adopted many old devices and invented others. This still goes on — but I envisioned this process of cooling and dehumidifying applied to human comfort and health (as well as in manufacturing) and predicted it in writing in 1905 and was laughed at."

The invention and development of the dew-point control system followed and in 1907 he patented the differential thermostat and differential hygrostat. After five more years of constant research among the factors related to the dehumidification of air through mechanical refrigeration, Dr. Carrier presented to the ASME his "Rational Psychrometric Formulae." This paper, delivered in 1911, disclosed for the first time the laws of psychrometry. It created a sensation and became a fundamental engineering doctrine.

After further exhaustive research in dew-point temperatures, much of it carried on in the laboratory of Cornell University, his alma mater, Dr. Carrier perfected in 1919 his previously published Psychrometric Chart. This stands today as the final authority on the subject.

• **BUSINESS.**— In 1907 Dr. Carrier and a group of his colleagues formed the Carrier Air Conditioning Company of America as a subsidiary of the Buffalo Forge Company. He was the guiding genius of the engineering and research division of the new company.

In 1915, the Buffalo Forge Company decided against further activity in the engineering phases of the air conditioning and refrigeration business, so the Carrier group established their own independent company—Carrier Engineering Corporation. Later, when the company combined engineering with the large-scale manufacture of air conditioning and refrigeration apparatus, the name was changed to its present form —Carrier Corporation.

One of Dr. Carrier's most important contributions to the science of air conditioning was his invention and design of the centrifugal refrigeration machine. It represented a tremendous advance over the reciprocating machine, particularly where large tonnages of cooling were required.

Since the development of the first centrifugal, he and his associates have constantly improved its capacity and range of application. Capable of using a great number of safe and harmless refrigerants, it can produce temperatures well under 150 degrees below zero.

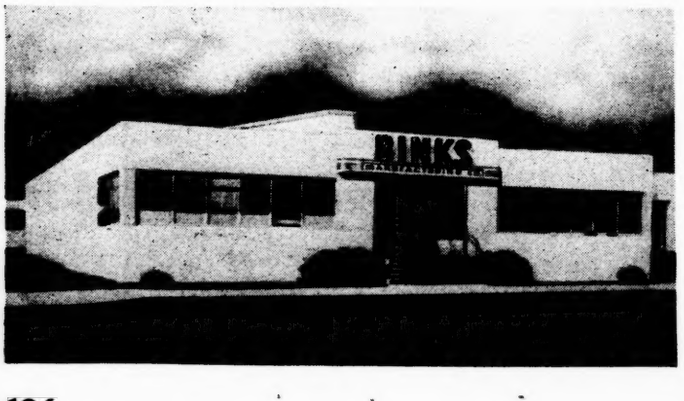
The centrifugal played a part in many of the long list of Carrier "firsts" in the air conditioning field. Carrier provided the first air conditioning not only in the printing and textile fields, but also made the first installations in paper mills, rubber, chemical, pharmaceutical, rayon, candy, aircraft, chewing gum, electrical and motion picture manufacturing plants. Equipment designed by Dr. Carrier went into the first air conditioned ship, railroad car, bus, theater, hospital, library, brewery, dairy, and department store. Carrier centrifugals also made possible the biggest air conditioning installations ever undertaken, including Radio City in New York and the Pentagon Building in Washington.

The combination of art and science developed by Dr. Carrier is being applied today as a necessity in more than 200 industries—revolutionizing some of them—in addition to a vast range of human comfort and health applications.

Dr. Carrier was born in Angola, New York, on November 26, 1876. He was the descendant of an English political refugee, Thomas Carrier, who migrated to America upon the restoration of Charles II. He attended various district schools in Erie County, New York; Central High School in Buffalo, New York; and was graduated from Cornell University in 1901. For many years he was a member of the Cornell Board of Trustees.

News Pix

(Left above) Dining areas of the Union Club of Tokyo, largest club facilities used by American Occupation Forces, have been air conditioned by Chrysler Airtemp packaged units installed by Nippon Air Conditioners, Inc.



(Above) Visitors to 32nd AGA convention in Atlantic City gather at the Owens-Corning Fiberglas display to watch a demonstration.

(Left) New plant of Binks Mfg. Co. at 4915 Pacific Boulevard, Los Angeles, will house expanding light manufacturing and warehousing facilities.

ASRE CONVENTION

plans completed. Program announced for annual meeting to be held in New York City.

Three technical sessions including a symposium on the heat pump, and special conferences on room air conditioners and on the domestic refrigerator, have been arranged as part of the program for the 46th annual meeting of the American Society of Refrigerating Engineers that is to be held at the Hotel Commodore, New York City, December 4-6.

• **FEATURES.**—Highlighting this year's meeting is a talk by Vilhjalmur Stefansson, world-famous arctic explorer; and a paper by Dr. Clarence A. Mills, professor of experimental medicine at the University of Cincinnati. On Tuesday afternoon there will be an inspection trip to observe the air conditioning installation of the United Nations Secretariat Building.

• **PROGRAM.**—The program follows:

Monday, December 4

9:30 a.m.—First Technical Session.

Development of a 20-ton Absorption Air Conditioning Unit, Eugene P. Whitlow, Servel Inc., Evansville, Ind.
The Future of Air Conditioning in Large Existing Buildings, Walter L. Fleisher, Consulting and Advisory Engineer, New York City.
Presentation of Wolverine and Best Section Papers Awards, by J. M. Lambert, Chairman of Awards Committee.
Reflective Radiant Conditioning at 'Reflection Point,' Clarence A. Mills, University of Cincinnati.

12:30 p.m.—Welcome Luncheon — address by Vilhjalmur Stefansson on Natural Cold Storage.

2:30 p.m. — Second Technical Session: Heat Pump Symposium.

Recent Progress in Electric Heat Pump Development, W. B. Friend, Ebasco Services, Inc., New York City.
General Electric All-Year, All-Weather Conditioning, S. J. Levine, General Electric Co., Bloomfield, N. J.
Report on Use of an Unloading Compressor in a Heat Pump Installation, R. A. Gonzalez, Airtemp Div., Chrysler Corp., Dayton, Ohio.
Living with a Thousand Marvairs, M. M. Smith, Muncie Gear Works, Muncie, Ind.
The Heat Pump Water Heater, Practical Information on Design and Field Test Results, A. W. Ruff, V. C. Patterson & Associates, York, Pa.
A Survey of Heat Pump Research and Development Projects, C. H. Coogan Jr., University of Connecticut, Storrs, Conn.

2:30 p.m.—Domestic Refrigerator Engineering Conference.

Part I—Continuation of the June 1949 discussion of Field Testing of Refrigerators.
Part II—Other Tests of Completed Refrigerators.

9:00 p.m.—Gay Nineties Party—floor show, barber shop quartet, songfest, sponsored by Northern New Jersey Section.

Tuesday, December 5

9:30 a.m.—Third Technical Session.

ASTM-ASRE Cooperative Development of Tests for Lubricating Oils, K. G. Mackenzie, The Texas Co., New York City.
Effect of Vapor Binding on Heat Transfer Coefficients in Horizontal Tube Evaporators, W. L. Bryan, Case Institute of Technology, Cleveland, Ohio.
The Dynamic Characteristics of a Solid Adsorbent, W. L. Ross and E. R. McLaughlin, Pennsylvania State College, State College, Pa.
Role of Absorption Type Desiccant within Refrigeration Units, W. A. Pennington, Carrier Corp., Syracuse, N. Y.

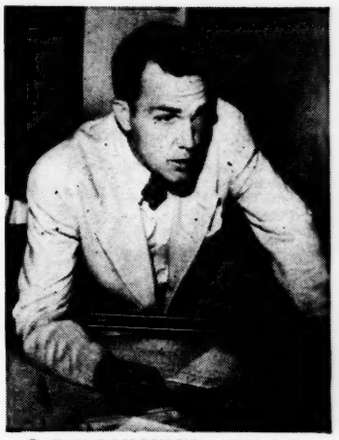
9:30 a.m.—Room Air Conditioner Conference.

Quality Control in the Manufacture of Room Air Conditioners, F. E. Dennison and L. V. Curran, York Corp., York, Pa.
Deodorizers and Their Application to Room Air Conditioners, John H. Bartol, W. B. Connor Engineering Co., Danbury, Conn.
Germicidal Lamps and Their Application to Room Air Conditioners, L. J. Buttolph, General Electric Co., Bloomfield, N. J.

1:00 p.m.—Publications Committee Luncheon Meeting.

Special luncheons as announced.

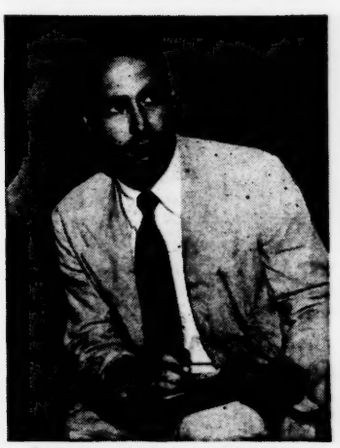
These men are working for you



C. B. McLAUGHLIN, active, fast-thinking Manager of Tube Turns' Engineering Service Division, checks important design point on new application idea.

Enthusiastic, enterprising G. A. GAUM, Sales Engineer, winds up extensive field trip with information that may save Tube Turns' customers time and money.

D. R. CHEYNEY, alert, ingenious Sales Engineer, visits a Tube Turns' customer with recommendations on alloy fittings designed to whip corrosion problem.



Conscientious, analytical J. D. TOLLIVER, Sales Engineer, goes into the field for performance data that can result in important contribution to piping technology.

IMPORTANT link between Tube Turns, Inc. and its customers is the group of skilled, experienced engineers who staff its Engineering Service Division. Their job: to expand piping technology through studies of piping performance and problems in the field; to enlarge the scope and utility of Tube-Turn welding fittings and flanges.

Today, the men of Engineering Service are making allies of alloys, solving major piping puzzles, extending the advantages of welding fittings and flanges to non-piping fields. Examples: development of the first aluminum flanges, making possible all-welded, all-aluminum piping systems; design of lighter, stronger truck axles fabricated with Tube-Turn welding fittings.

Ideas are their stock-in-trade . . . ideas focused on one basic objective: *new and better ways for welding fittings and flanges to serve you better.*

Write for free booklet on "TUBE-TURN Aluminum Welding Fittings and Flanges."

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TUBE TURNS, INC.

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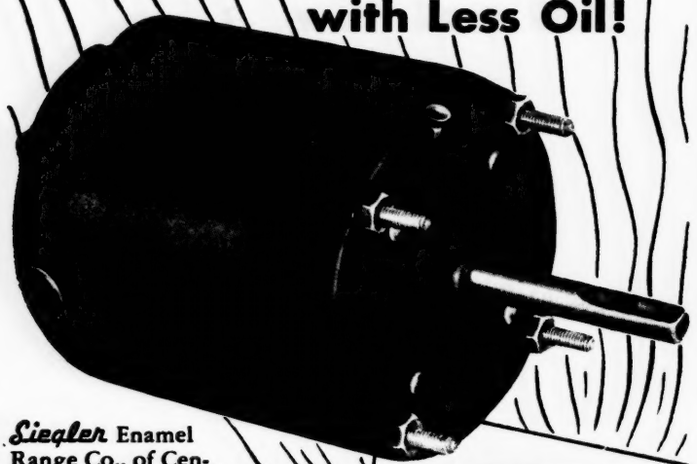
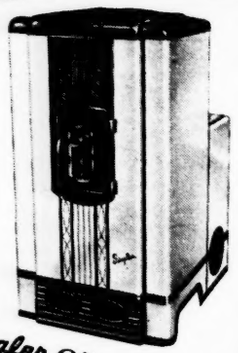
FASCO
FRACTIONAL H. P. MOTORS
...Help Siegler
Produce Twice the Heat
with Less Oil!



Siegler Enamel Range Co., of Centralia, Ill., is famous throughout America for dependable, economical, efficient oil and gas heaters. The Siegler Oil Heater, for instance, provides heat by gravity circulation for mild weather conditions; or by forced hot air when a lot of heat is wanted quickly. A high quality FASCO motor powers the forced air assembly at any of three desired volumes . . . using less electric current than a 40-watt light bulb . . . producing twice the heat . . . and saving many dollars in fuel bills. The motor may be used continuously or intermittently for dependable peak performance results.



Siegler Oil Heater

There's a complete line of FASCO Fractional H. P. shaded pole motors from 1/500 to 1/8 H. P. to help *you* improve your product, or pack maximum efficiency and economy into the design of your new one.

"Your comparison test, too, will prove FASCO *best"*

WRITE for complete information on FASCO Fractional H.P. Motors.

FASCO
INDUSTRIES, INC.
ROCHESTER 2, NEW YORK

2:30 p.m.—Inspection Trips.

New York Steam Corp., refrigeration equipment.
United Nations Secretariat Building, air conditioning installation.

2:30 p.m.—Committee Meetings.

Standards Committee.
General Technical Committee.
Admissions and Membership Committees.
Research Committee.

4:00 p.m.—Committee Meetings.

Program Committee.
Constitution Committee.
Awards Committee.
Education Committee.

6:00 p.m.—Cocktail Party.

7:00 p.m.—Dinner Dance.

Presentation of awards to the developers of a modern refrigerant.

Wednesday, December 6

10:00 a.m.—Fourth Technical Session.

Restrictor Tubes, N. E. Hopkins, York Corp., York, Pa.
Self-Service Merchandising of Packaged Perishables, Nelson Allen, E. I. du Pont de Nemours & Co., Wilmington, Del.
Storage of Confections, J. G. Woodroof and Helen H. Thompson, Georgia Agricultural Experiment Station.

12:30 p.m.—Induction of 1951 Officers.

1:00 p.m.—Council Luncheon Meeting.

U. OF WISCONSIN

plans two three-day courses in heating.

Two "engineering institutes," on the pattern of short courses, in the heating field are to be conducted at the University of Wisconsin as part of a series of 18 institutes designed to provide additional technical training.

They are "Steam and Hot Water Heating," Feb. 13-14-15, 1951, and "Warm Air Heating and Air Conditioning," March 13-14-15, 1951.

The institute on steam and hot water heating is planned to have sufficent scope to cover the entire field of this heating type. The other will cover the problems involved in the installation and servicing of all types of warm air heating.

At both institutes basic information as well as the latest developments and techniques will be presented.

Enrollments are limited. Prof. H. E. Pulver, of the University Extension Division at Madison, is in charge of inquiries and enrollment. The instructional staff will be made up of men in industry and faculty members of the University's college of engineering and the extension division.

• A checkup of Army orders for the fiscal year 1950, ending July 31, 1951, shows that small business concerns secured more than 74.1% of contracts and 40.6% of the dollar value of contracts placed, according to Secretary of the Army, Frank Pace, Jr.

• More than 15,000 people toured the entire Wagner Electric Corp. plant in a scheduled open house for employees, stockholders, customers and others, October 14 and 15.

*Airsan** Air Filter Protection Means Effective Dust Collection

Airsan expanded metal face plate acts as a lint arrestor to provide easier cleaning and servicing and distributes air evenly over entire filtering area, providing high filtering efficiency and dust holding capacity with low resistance. Other features include all galvanized construction and full bronze welded corners.

Airsan Air Filters available in standard 1" and 2" thickness with filters for industrial and special applications in 2" and 4" thickness. Holding frames (for V type or straight banks) are made for all type filters.

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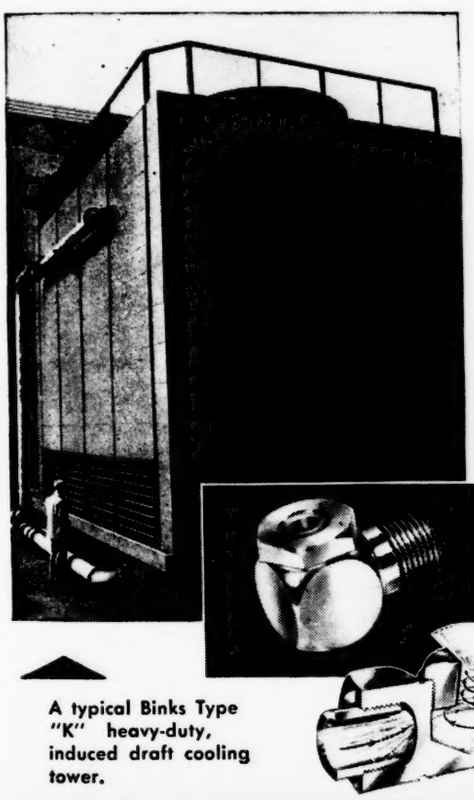
A Few Distributorships Available. Write for Details.



A typical Binks Type "K" heavy-duty, induced draft cooling tower.

Clog-proof Rotojet nozzles are used in both the spray-filled and deck-filled towers.

For large scale water cooling . . .

Binks Type "K" Towers cut your costs

Eliminate costly water consumption

Let a Binks Type "K" heavy-duty, induced draft tower cut your cooling-water costs by reducing water consumption to the minimum. The same cooling water is circulated over and over. A small power charge for pumping takes the place of a big water bill.

Assure better performance

Type "K" cooling towers give high cooling efficiency...the correct air to water ratio. They create their own breezes...are independent of natural air circulation. This is a big advantage in crowded locations. Binks Rotojet Nozzles insure correct fluid breakup for maximum heat dispersal.

Binks Type "K" towers are used extensively in connection with large-scale air conditioning, refrigeration, and related applications. They are made in a range of standard sizes in both deck-filled and spray-filled models. A Binks engineer will gladly help you solve cooling problems.

Send today for technical bulletins describing Binks Type "K" Induced Draft Cooling Towers. Ask for:

Bulletin 36—Type 2KS Spray Filled Cooling Towers (150 to 645 GPM)

Bulletin 37—Type 2K-W Wood Filled Cooling Towers (150 to 495 GPM)

Bulletin 39—Heavy-duty Type "K" Cooling Towers (1000 to 3000 GPM)

THERE'S A BINKS TOWER FOR EVERY COOLING JOB

Binks MANUFACTURING COMPANY

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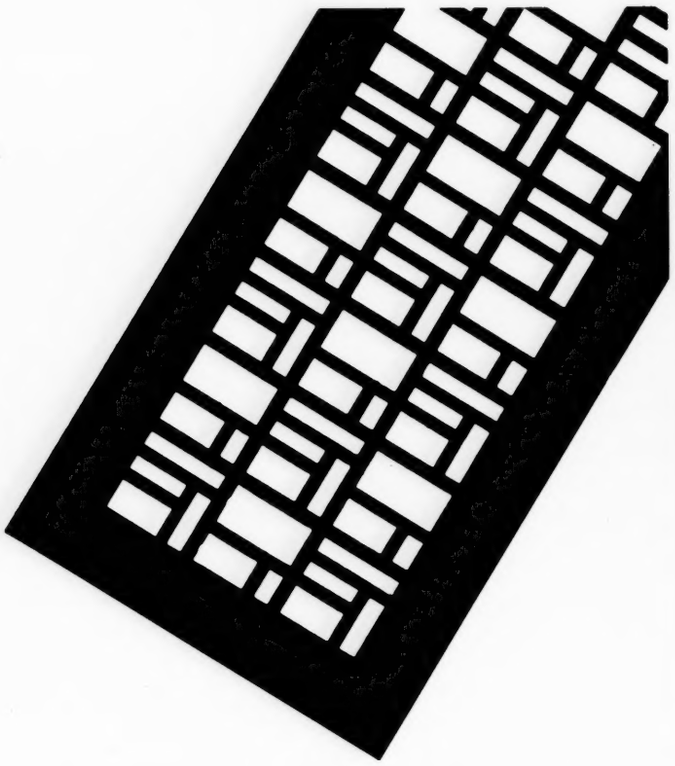

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one of the hundred distinctive designs in the famous line of Hendrick Ornamental Grilles.

Many of these designs were originally developed, according to an architect's specifications, to harmonize with the decorative scheme for some outstanding public building or residence. They are now available as standard numbers.

Hendrick Grilles are furnished in heavy-gauge aluminum, bronze, copper, Monel, steel and stainless steel. Ample open areas assure good air flow. Sizes are accurate, perforations clean-cut, and there are no burrs or other imperfections. Installation is easy because a special flattening operation in their manufacture gives the grilles uniformly flat surfaces.

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Workers in atomic energy labs are protected from harmful vapors by this electronic control demonstrated by Lou Belford, New York regional manager of the Minneapolis-Honeywell Regulator Company. The velocity controller which keeps the air free of radioactive particles is one of 38 operating models of the newest electronic, electric and pneumatic controls exhibited in Minneapolis-Honeywell's "Parade of Progress" show, currently on a tour of 60 cities.

• Roy O. Nelson has formed a new organization known as the Roy O. Nelson Company, manufacturers' representative, at 330 S. Wells Street, Chicago 6, Ill. The C. H. Bevington Company, predecessor organization, is being dissolved. Companies represented currently are Vulcan Radiator Co., Skidmore Corp., Davidson Fan Co., and Overhead Heaters, Inc.

• John Hellstrom, vice president of American Air Filter Company, Inc., became manager of the newly created Pacific Division in San Francisco, November 1. Both American Air Filter and Herman Nelson activities will be under his direct supervision.

• Tulsa, Oklahoma, refrigeration and air conditioning firms, in cooperation with city officials, are drawing up a code regulating refrigeration and air conditioning systems and changing the present boiler inspection department with powers to enforce the code. Code is modeled on that of the ASRE.

• The board of directors of the Stoker Manufacturers Association, meeting in Chicago, October 23, established a special committee which will be known as the S.M.A.—Government Liaison Committee. C. T. Burg of Cleveland, Ohio, president of the association, stated the committee is being organized in order to act on behalf of the association and the underfeed stoker industry on matters and problems concerning government regulations and legislation of all kinds, including relationships with the various and numerous new agencies operating under the Department of Defense and the National Security Resources Board. Chairman of the committee is Claude A. Potts, immediate past president of the Association, of Lebanon, Indiana, and vice president, U. S. Machine Corp. Members of this committee are associated with nine companies which are members of the Association. Executives of two nonmember stoker manufacturers will be invited to serve on the committee.

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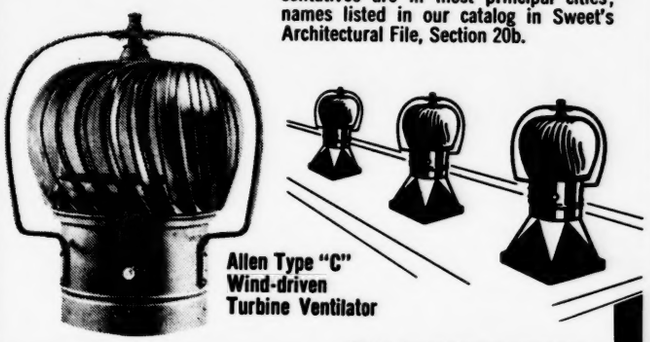
TURBINE VENTILATORS

Accurately rated, wind-driven Allen Turbine Ventilators are doing a noteworthy air-displacing job on commercial and industrial rooftops all over the country. Ruggedly built of prime sheets of heavy-gauge coated iron, (special, non-ferrous metals also available), these almost noiseless ventilators are in stock, ready for immediate delivery to you. Throat diameters, 6 to 48 inches. Economical to install and maintain, Allen Turbine Ventilators give maximum performance per dollar spent. Another type, motor-equipped Electro-Wind Turbine Ventilator, is available for use in areas where wind velocities are not always sufficient. Engineering assistance gladly furnished. Our representatives are in most principal cities; names listed in our catalog in Sweet's Architectural File, Section 20b.



Allen Type "C" Wind-driven Turbine Ventilator

Write for catalog on complete line of roof ventilators.

ALLEN ENGINEERED VENTILATION

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Roof Ventilators for Every Commercial and Industrial Need

PHILLIPS
FLOAT CONTROLS

PILOT OPERATED LIQUID CONTROL VALVE FOR LARGE EVAPORATORS

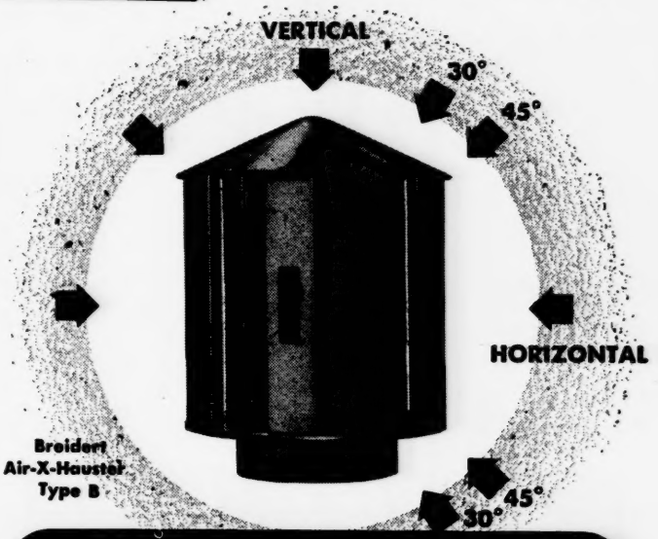
701 JR. F.

Leading manufacturers of water chillers use and recommend these valves. The Phillips pilot operated valve responds accurately to a small modulating pilot which may be either a thermostatic or float type expansion valve. They double as a liquid stop valve by use of small solenoid valve in pilot line. Capacities with "Freon" from 20 to 750 tons; Ammonia 30 to 2000 tons. For high or low side applications. WRITE FOR BULLETIN.

A Successful Company built upon the founder's earnest wish to be of service to the Customer and the Industry

H. A. PHILLIPS & CO. - CHICAGO
DESIGNERS AND ENGINEERS REFRIGERATION CONTROL SYSTEMS
3255 W. Carroll Ave. Chicago 24, Ill., U.S.A.

First Ventilator with Certified Capacity Ratings!



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The Revolutionary Improvement in Roof Ventilators and Chimney Tops

Only the Breidert Air-X-Hauster offers certified capacity ratings based on tests* made with wind blowing in **all** directions as shown above. Only such tests can guarantee the capacities a ventilator will deliver under actual operating conditions! No matter which way the wind blows, barring interior negative pressures, the Breidert provides safe, sure ventilation.

For Chimney Tops . . . the Breidert Air-X-Hauster stops down-draft, exhausts smoke and fumes, completely overcomes sluggishness caused by down-draft. Thousands of Breiderts are in use all over the country.

For Vent Flues . . . the Breidert succeeds when conventional ventilators fail because it completely eliminates back-draft where no interior negative pressure exists. Positive flue action is assured regardless of wind direction. The Breidert is more compact and neat in appearance.

For Roof Ventilating . . . the Breidert is unsurpassed in efficiency, economy and appearance for use on residence, commercial and industrial buildings of all types. Stationary . . . no moving parts . . . nothing to jam or get out of order.

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ENGINEERING DATA BOOK . . . . . Use the coupon for complete information on the Breidert Air-X-Hauster, including certified capacity ratings.

**By Smith, Emery & Co. of San Francisco, Pacific Coast Branch of the Pittsburgh Testing Laboratory.*

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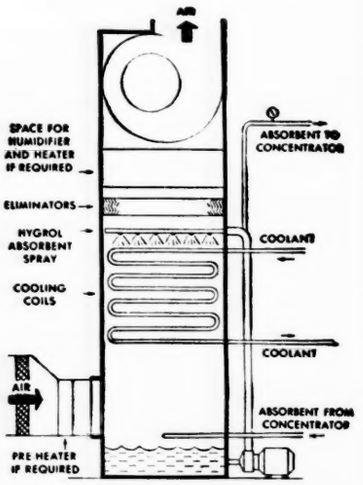
Using "Hygrol" Hygienic Absorbent Liquid

Because it absorbs moisture from the air directly, the new Niagara Controlled Humidity Method uses less, or no, mechanical refrigeration for dehumidifying. You save first costs and installing of heavy machinery. You save space, maintenance expense, power. Easier, convenient operation.

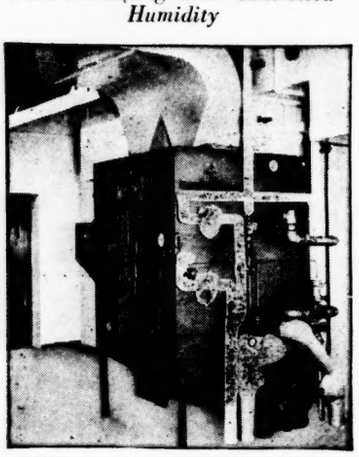


NIAGARA CONTROLLED HUMIDITY METHOD — FLOW DIAGRAM

Using "Hygrol" hygienic absorbent liquid, this method gives complete control of temperature and relative humidity. Especially, it is a better way to obtain dry air for drying processes, packaging hygroscopic materials, preventing moisture damage to metals, and obtaining better quality for chemical process products and food products—or in obtaining better results in comfort air conditioning for office or laboratory at lower refrigeration costs.

The diagram shows how filtered air is dehumidified by passing thru a spray of "Hygrol"— a liquid absorbent which removes air-borne moisture. This liquid is hygienic and non-corrosive; it contains no salts or solids to precipitate and cause maintenance troubles. It is continuously reconcentrated at the same rate at which it absorbs moisture, providing always the full capacity of the air conditioner, automatically.

Food Packaging under Controlled Humidity


Niagara Controlled Humidity Air Conditioner

Units provide a range of capacities from 1000 to 20,000 C. F. M. Multiple unit installations are in use successfully. Records of results are available.

For further information, write to Niagara Blower Company, Dept. HV, 405 Lexington Ave., New York 17, N. Y.

ABSTRACTS AND REVIEWS

Publications abstracted in this department should be ordered direct from publisher.

SNOW MELTING

A comprehensive treatise on the relatively new subject of snow melting systems for roads, driveways and sidewalks has just appeared under the title "Snow Melting," written by T. Napier Adlam and published by The Industrial Press, New York, N. Y.

Snow melting is usually accomplished by circulating hot water though pipe coils embedded beneath the road or walk surface, anti-freeze solutions being employed to prevent freezing of the fluid when snow is not falling. Another, but less popular, method is to use buried electrical cables.

"Snow Melting" covers not only the design of such systems, but includes detailed tables on amount of snowfall, air venting, pipe friction, pump selection, costs of installing and operating, and complete information on proper installing. Three chapters are devoted to descriptions and illustrations of installations already in operation. Of special importance are the 27 full-page working charts covering all types of construction, which speed up the computing of pipe size and spacing. Also included are tables giving snow data for 270 cities.

Chapter titles are as follows:

Feasibility and Cost of Removing Snow by Melting
Amount, Rate, and Density of Snowfall
Snow Melting Test Data and Test Set-Ups
Calculating the Heat Required for Snow Melting
Examples of Calculating Heat Requirements for Snow Melting
Pipe Friction and Expansion in Snow Melting Systems
Anti-Freeze Solutions and Their Use with Snow Melting Systems
Automatic Controls for Starting System When Snow Begins to Fall
Air Venting and Flow Adjusting in Snow Melting Systems
Snow Melting Systems Applied to Roads and Driveways
Snow Melting Systems Applied to Sidewalks
Special and Dual Purpose Applications of Snow Melting
Costs to Install and Operate Snow Melting Systems
Summary of Design Procedure for Snow Melting and Charts for Pipe Sizing and Spacing

The author has pioneered in designing, installing and testing of such systems. Nearly a decade ago he designed a system of piping through which hot water circulated to melt snow from sidewalks at the Bethlehem, Pa., plant of which he is works manager. The system was so set up that test data were accumulated over a period of years. He has also acted as consultant on a considerable number of similar installations throughout the country, and is the author of the popular "Radiant Heating" now in its second edition.

Snow Melting, by T. Napier Adlam. Cloth bound,

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If the buckets in your steam traps wobble like an old car, it will pay you to switch to Super-Silvertops. Only Super-Silvertops have guided buckets which prevent sloppy bucket action. A guided tube controls the bucket, eliminating bucket swing which causes bucket damage and leads to high replacement costs. In addition, the exclusive Super-Silvertop bucket lever assures positive seating . . . preventing costly leakage of live steam. This bucket lever also fastens off-center, thereby increasing leverage available for creating greater valve opening power and capacities. Only Super-Silvertops give you these cost-cutting advantages. These features, plus instructive information on the sizing of steam traps for many installations, are discussed in Anderson's famous booklet "Solving Steam Trap Problems". Write for your copy today.

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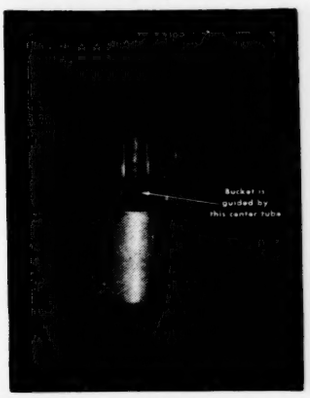

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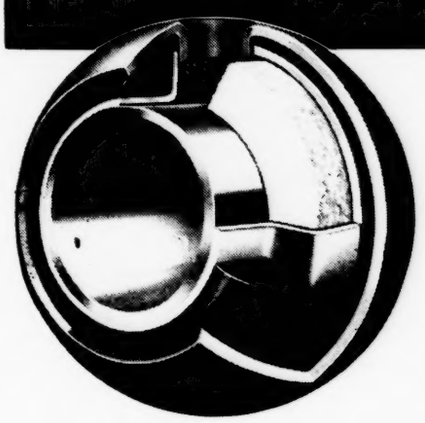

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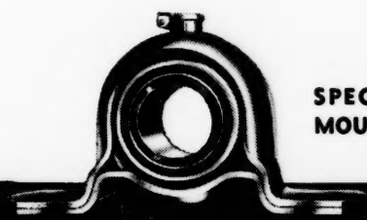

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- Machine tool cut and beveled.
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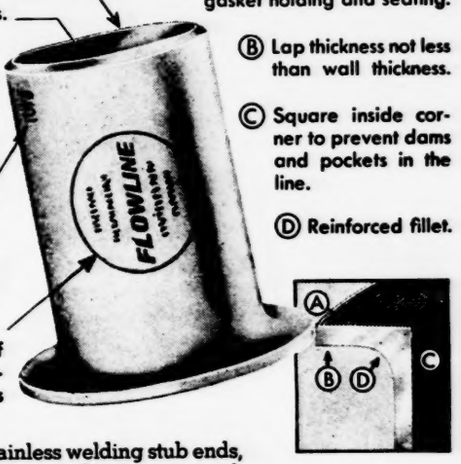

Ⓐ Serrated face for improved gasket holding and seating.

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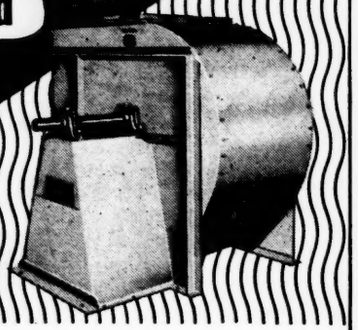

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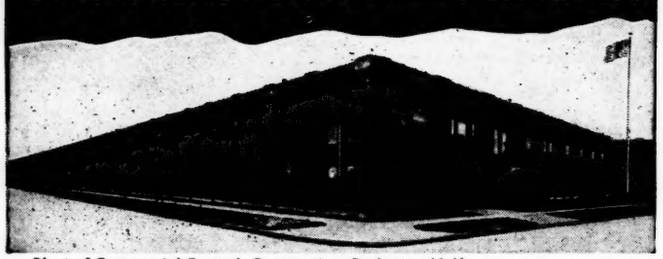

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6 x 9 inches, 224 pages, including 189 illustrations. Published by The Industrial Press, 148 Lafayette St., New York 13, N. Y. Price, $4.50.

REFRIGERATION ENGINEERING

The first edition of Refrigeration Engineering by the late H. J. Macintire, professor of refrigeration, University of Illinois, was published in 1937 as a successor to the Handbook of Mechanical Engineering by the same author. Before his death, plans were made with F. W. Hutchinson, professor of mechanical engineering, University of California, for a new edition. Prof. Hutchinson, in writing the new manuscript, followed through these ideas.

Like the first edition, the second edition is intended to serve as a college textbook and as a reference volume for engineers. About one-half of the material in this volume is entirely new and eight new chapters have been added. Included are over 200 problems of which 160 are new in this edition.

After the authors explain fundamental thermodynamics, fluid flow and theoretical cycles of refrigerants, descriptions are given of commercial equipment and material included covering special applications of refrigeration engineering. Included are more than 30 full-page graphical solutions giving direct reading values of the film coefficient of heat transfer for most of the commonly used refrigerants when being heated or cooled. These charts were originally published in HEATING AND VENTILATING.

The text which is divided into sections on thermodynamics of reversed cycles, load determination, and refrigeration equipment, is again divided into the following chapters:

Energy relationships in refrigeration; energy equations and ideal cycles; simple refrigeration cycles; analysis of complete systems; the heat pump; adsorption and absorption systems; refrigeration and properties of saturated and superheated vapors; conduction and convection; steady-state load calculations; transient loads; panel cooling; air conditioning methods; fluid flow; compression refrigerating machines; automatic refrigerating machines; erection, operating and testing; condensers; evaporators; cold storage; ice manufacture; special applications of refrigerating engineering.

Refrigeration Engineering, by H. J. Macintire and F. W. Hutchinson. Cloth bound, 6 x 9 inches, 610 pages. Published by John Wiley & Sons, Inc., 440 4th Ave., New York 16, N. Y. Price, $6.50.

ARC WELDING LESSONS

The complete series of forty arc welding lessons in electric arc welding offered at Hobart Trade School, Inc., Troy, Ohio, are now available in book form. The text is easy to follow and is well illustrated.

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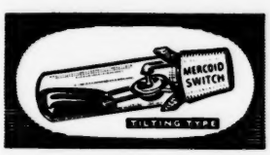

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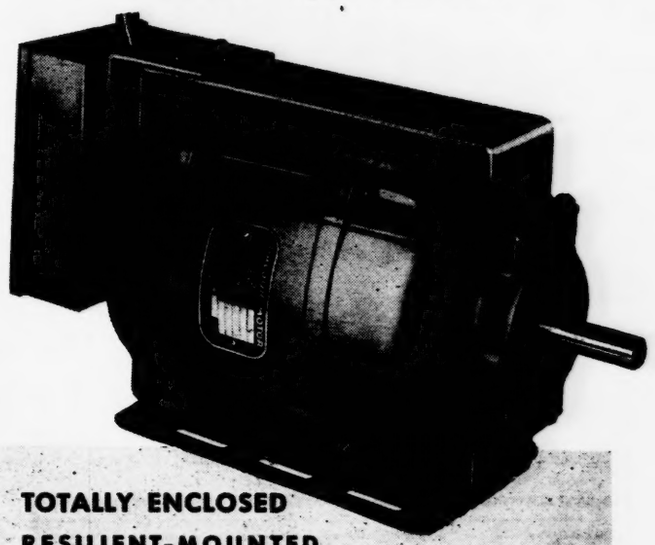

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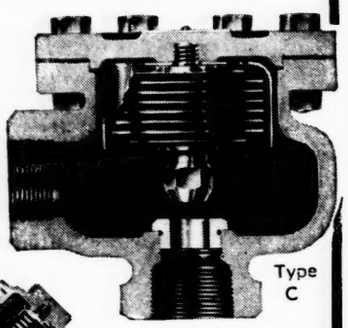

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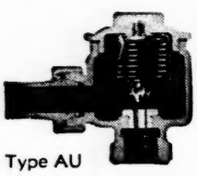

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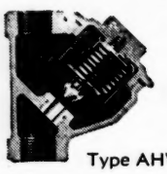

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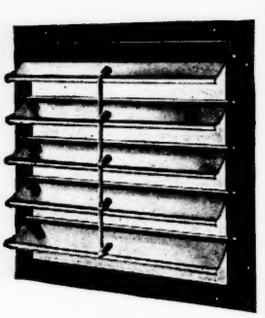

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This volume is the second part of the new 5-part handbook, Electric Arc Welding—Procedure and Practice. Some of the chapters that are covered in the new text are: Preliminary instructions; starting and manipulating the arc; welding common joints with bare electrodes; welding light gage sheets with coated electrodes; general welding with coated electrodes in the flat, horizontal, vertical and overhead positions; pipe welding; welding cast iron; and special practices and tests.

Modern Arc Welding Lessons, AC and DC. Flexible fabricoid cover, 5½ x 8 inches, 431 pages. Published by Hobart Trade School, Inc., Troy, Ohio. Price, $1.

PLANT ENGINEERING HANDBOOK

Information on 76 major phases of plant organization, design, construction and maintenance are covered by 87 specialists connected with 45 prominent industrial organizations and 5 universities.

This volume, which is intended to supplement rather than supplant the standard engineering handbooks, is written to serve industry. It presents in compact form material that appears in greater detail in specialized reference works. It covers many subjects vital to efficient industrial and institutional operations. The book has been designed to provide the answers to common problems that develop in industry.

Material is divided into 35 chapters or sections as follows: Basic industrial costs and cost reduction; management engineering; foundations and reinforced concrete; materials of construction; fire prevention and protection; fundamentals of good plant maintenance; water purification and treatment; power plants; refrigeration; instrumentation and control; industrial piping; welding; power distribution and lighting; mechanical power transmissions; bearings; electrical speed control; lubrication; mechanical packings; materials handling; industrial process air conditioning; pneumatic conveying, dust control and fume exhaust; crushing and grinding; drying; corrosion; trade waste disposal; heat transfer; physics in industry; graphical mathematics; vibration and control; packaging; industrial glass; plastics; patents and copyrights.

Plant Engineering Handbook, William Staniar, editor. Cloth bound, 6 x 9 inches, 2007 pages. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 18, N. Y. Price, $15.

HUMAN ENGINEERING

While intended primarily for the design engineer, the Handbook of Human Engineering contains information of value to production men in all fields. Essentially, it is a compilation of known data in each of the fields of human engineering, including summaries of principal experiments and basic bibliographies. It was prepared by the Tufts College Institute for Applied Experimental Psychology under a research contract with Navy's Special Devices Center.

A glossary of some 500 terms used in this field is included as well as an author and subject index.

Eight broad sections of the book deal with human machine and human engineering, the human body, characteristics of vision, factors involving the efficiency of hearing, skin sensitivity, and proprioception, motor responses, physiological factors regarding sleep, temperature, and drugs, and intelligence.

Handbook of Human Engineering Data for Design Engineers, published by the U. S. Department of Commerce, Office of Technical Services, Washington 25, D. C. Price, $5.

• • •

FIBERGLAS BIBLIOGRAPHY—Annotated references to selected articles which have appeared in the press concerning Fiberglas has been published under the title Fiberglas Bibliography. The 1950 volume represents the third edition of this publication. This bibliography consists of 88 pages, and lists 710 references to articles in 338 publications. Owens-Corning Fiberglas Corporation, Toledo, Ohio.

FOUNDRY INDUSTRY SYMPOSIUM—The 1950 Foundry Industry Symposium contains articles relating to foundry industry and production that have been published in a number of technical magazines and papers which were presented before various technical societies. This paper-bound book of 114 pages contains 19 articles and papers. The Consolidated Reporting Company, 303 Fourth Avenue, New York 10, N. Y. Price, $3.15.

AIR CONDITIONER RATING STANDARD—An ASRE standard for testing and rating air conditioners has recently been issued by the American Society of Refrigerating Engineers. This standard was approved by the Society at its last annual meeting and covers self-contained air conditioners, room air conditioners, remote type air conditioners, heat pumps, and oil- and gas-fired air conditioners. It consists of a revision of two former ASRE standards; namely, No. 16 covering Methods of Rating and Testing Self-Contained Air Conditioning Units for Comfort Cooling, and No. 13, Methods of Rating and Testing Air Conditioning Equipment. Copies of this standard, 16R, may be obtained from the American Society of Refrigerating Engineers, 40 West 40th St., New York 18, N. Y. Price, $1.

TESTING UNIT HEATERS—Bulletin No. 10, the Standard Code for Testing and Rating Steam Unit Heaters, Second Edition, has just been released by the Industrial Unit Heater Association. It supersedes the first edition, 1930, which was prepared and adopted jointly by the Association and the American Society of Heating and Ventilating Engineers. The second edition is issued under the same authorities. The fundamental engineering has not been changed. Improved testing equipment, instruments and technique have developed through the years and the purpose of the second edition is to recognize such advances. Industrial Unit Heater Association, 2159 Guardian Bldg., Detroit 26, Mich.

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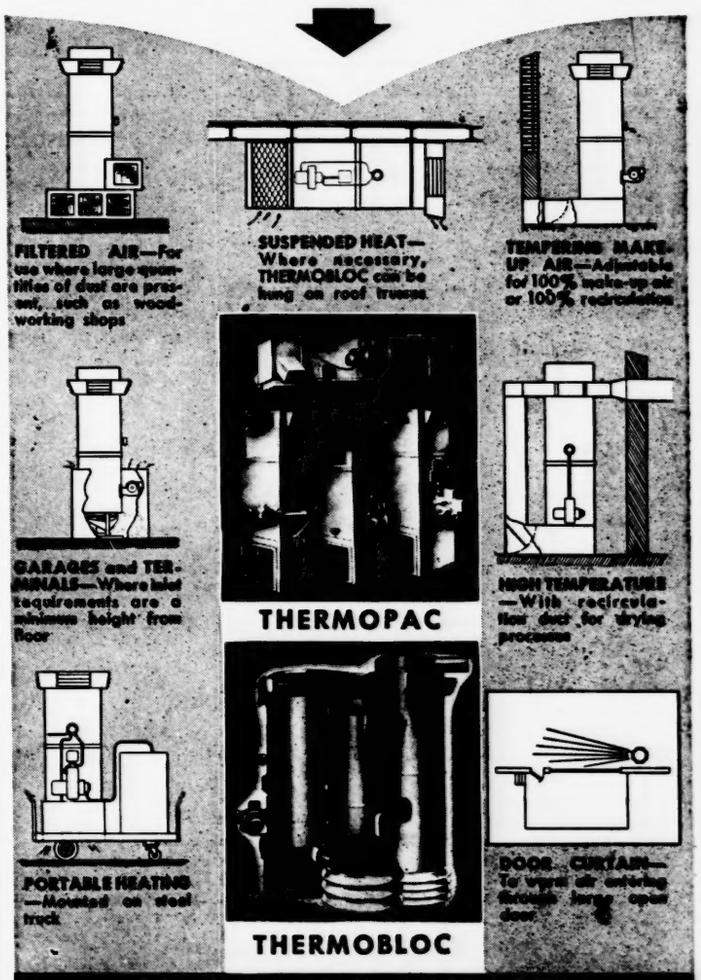
The Prat-Daniel Corporation, manufacturers of THERMOBLOC offer a new technical bulletin to aid you in estimating your heat losses. Write for your copy today!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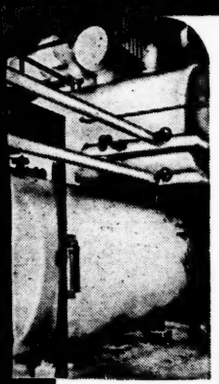

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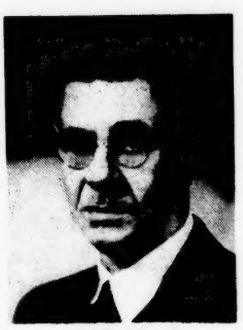
Getting Personal

D. F. Bennett

D. F. Bennett *(Wall to Wall Convector Radiation for School Buildings*, page 62) is manager, radiation and unit heater sales, Warren Webster & Co., Camden, N. J. A native of Ohio, he studied mechanical engineering at Ohio State University. He was employed by the Buckeye Blower Co. for six years as junior engineer, engineer, and assistant to chief engineer. In 1931 when the Buckeye Blower Co. was merged with John J. Nesbitt, Inc., Philadelphia, Mr. Bennett joined the Nesbitt organization, serving first as engineer in charge of unit heater applications and later in charge of unit heater sales. In 1940, Mr. Bennett became associated with Warren Webster & Co., as manager of the Radiation and Unit Heater Division. In this position he has had primary responsibility for development of sales of Webster-Nesbitt unit heaters, Webster system radiation, Webster baseboard heating, and Webster Walvector.



E. B. Shand

E. B. Shand *(Industrial Glass Piping*, page 67), staff sales engineer, Corning Glass Works, Corning, N. Y., was born in Canada and was schooled in electrical engineering at McGill University. Except for the period interrupted by World War I, for 20 years he was engaged in the development and design of electrical machinery.

He joined the Corning Glass Works in 1936 to work on the application of certain glass products in the electrical industry. Mr. Shand later transferred to organizing activities of product engineering on glass products in technical use. During this time, and later in connection with staff duties, he made a special study of glass as stream-bearing members for a wide variety of applications.

He is a member of the ASME, AIEE, American Ceramic Society, and the Society of Glass Technology of Britain.

COMING EVENTS

Where listed, names or titles of individuals are those from whom further information is available.

REFRIGERATION WEST COAST EXHIBIT—West Coast Educational Exhibit and Conference, of the Refrigeration Equipment Manufacturers Association, at Municipal Auditorium in Long Beach, Calif., to be held simultaneously with 5th annual convention of the Refrigeration & Air Conditioning Contractors Association. Edna Berggren, executive secretary, 228 No. La Salle St., Chicago 1, Ill. .....**NOVEMBER 17-19, 1950.**

ASME MEETING—Annual meeting of the American Society of Mechanical Engineers, at the Hotel Statler, New York, N. Y. C. E. Davies, secretary of the Society, 29 W. 39th St., New York, N. Y. .....**NOVEMBER 26—DECEMBER 1, 1950.**

POWER SHOW — 19th National Exposition of Power and Mechanical Engineering, sponsored by the American Society of Mechanical Engineers, in conjunction with the society's annual meeting, at Grand Central Palace, New York, N. Y. Charles F. Roth, president, International Exposition Company, Grand Central Palace, New York.....**NOVEMBER 27—DECEMBER 2, 1950.**

ASRE MEETING—Annual convention of the American Society of Refrigerating Engineers, at Hotel Commodore, New York. M. C. Turpin, secretary, 40 W. 40th St., New York 18, N. Y. .....**DECEMBER 3-6, 1950.**

AUTOMOTIVE ENGINEERS MEETING—Annual meeting and engineering display, of the Society of Automotive Engineers, at the Hotel Book-Cadillac, Detroit, Mich. John A. C. Warner, secretary of the Society, 29 West 39th Street, New York, N. Y. .....**JANUARY 8-12, 1951.**

PLANT MAINTENANCE SHOW AND CONFERENCE—2nd plant maintenance show and conference, at the Auditorium, Cleveland, Ohio. Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y. .....**JANUARY 15-18, 1951.**

ASHVE MEETING—57th annual meeting of the American Society of Heating and Ventilating Engineers, at the Bellevue-Stratford, Philadelphia, Pa. A. V. Hutchinson, secretary of the Society, 51 Madison Ave., New York 10, N. Y. .....**JANUARY 22-25, 1951.**

ASHVE EXPOSITION—10th International Heating and Ventilating Exposition under the auspices of the American Society of Heating and Ventilating Engineers, at the Commercial Museum, Philadelphia, Pa. Charles F. Roth, manager of the International Exposition Company, Grand Central Palace, New York 17, N. Y. .....**JANUARY 22-26, 1951.**

ASME MEETING—Spring meeting of the American Society of Mechanical Engineers, at the Hotel Atlanta-Biltmore, Atlanta, Ga. C. E. Davies, secretary of the Society, 29 W. 39th St., New York, N. Y. .....**APRIL 2-5, 1951.**

LUBRICATION SHOW — Annual convention and lubrication show of the American Society of Lubrication Engineers, at the Bellevue-Stratford Hotel, Philadelphia, Pa. W. F. Leonard, secretary of Society, 343 South Dearborn Street, Chicago 4, Ill. .....**APRIL 16-18, 1951.**

FOUNDRYMEN'S CONVENTION—55th annual convention of the American Foundrymen's Society, in Buffalo, New York. William W. Maloney, secretary-treasurer of the Society, 616 S. Michigan Ave., Chicago 5, Ill. .....**APRIL 23-26, 1951.**

REFRIGERATION MEETING—Annual meeting of the Refrigeration Equipment Manufacturers Association, at The Homestead, Hot Springs, Va. George E. Mills, public relations director, REMA, 1346 Connecticut Ave., N.W., Washington, D. C. .....**APRIL 30—MAY 2, 1951.**

ARCHITECTS CONVENTION—1951 convention and national seminar meetings of The American Institute of Architects, at the Edgewater Beach Hotel, Chicago, Ill. Paul Gerhardt, Jr., chairman, 121 No. LaSalle St., Chicago, Ill. **MAY 8-11, 1951.**

NDHA MEETING—42nd annual meeting of the National District Heating Association, at the Statler Hotel, Detroit, Mich. John F. Collins, Jr., secretary-treasurer of the Association, 827 N. Euclid Ave., Pittsburgh 6, Pa.....**JUNE 5-8, 1951.**

INSTRUMENT CONFERENCE AND EXHIBIT—1951 Instrument conference and national exhibit of the Instrument Society of America, at the Coliseum, Houston, Tex. John McCaffery, assistant executive secretary of the Society, 921 Ridge Ave., Pittsburgh 12, Pa. .....**SEPTEMBER 10-14, 1951.**

REFRIGERATION SHOW—7th All-Industry Refrigeration and Air Conditioning Exposition, at Navy Pier, Chicago, Ill. Show director, REMA, 1346 Connecticut Ave., N.W., Washington, D. C. .....**NOVEMBER 5-9, 1951.**

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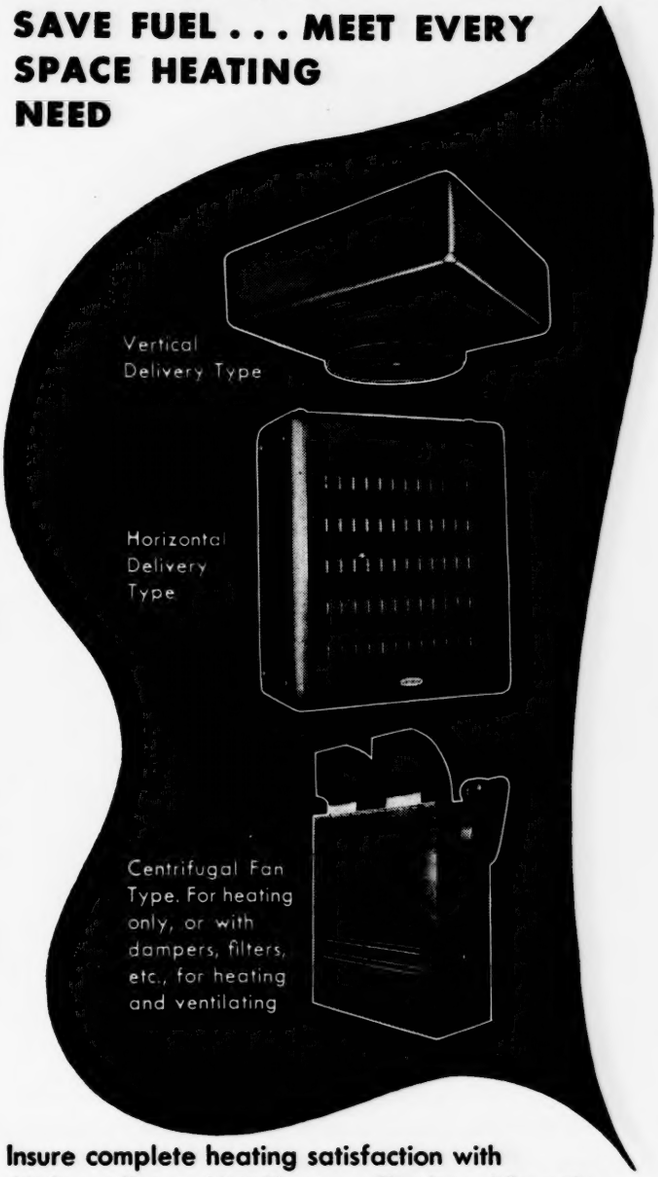
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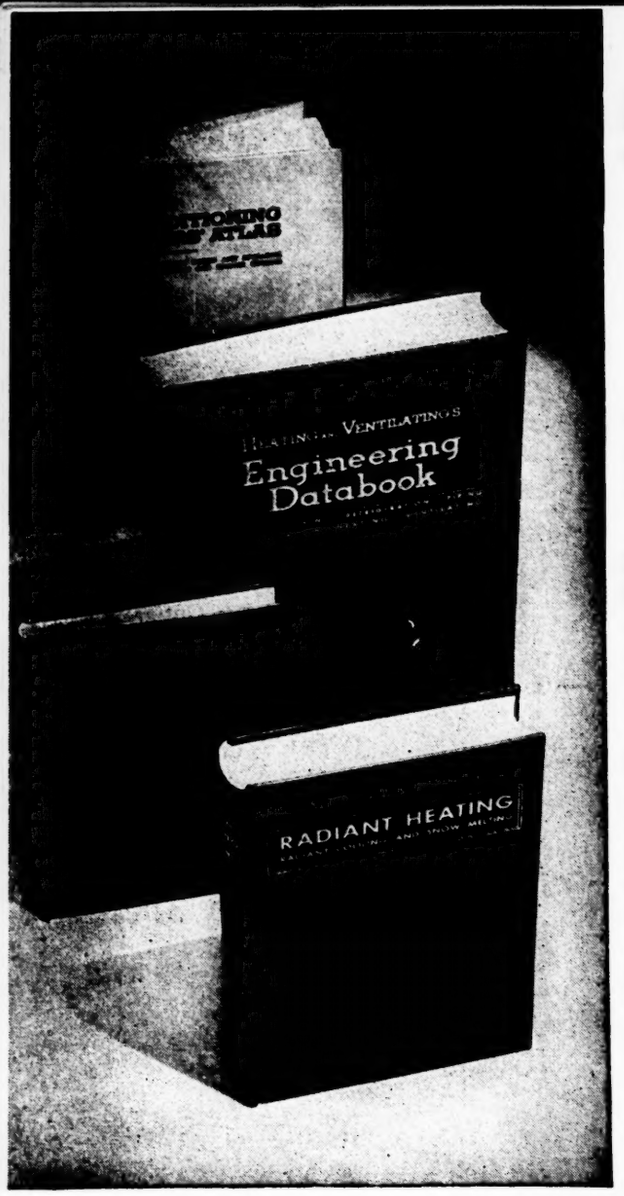

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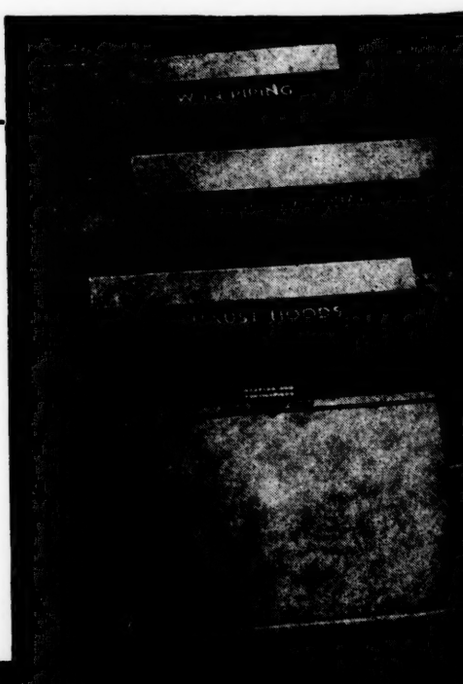

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ESTIMATING HEAT GAIN FROM LIGHTS

The purpose of the accompanying data is to assist the engineer in calculating the heat gain from lights, especially when the available information on the job is meager. The data are from an article by J. R. Jones, Lamp Div., Westinghouse Electric Corp., and W. B. Foxhall.

In connection with these data, a footcandle is the illumination at a point on a surface 1 foot from and perpendicular to a point source of 1 candle. The number of footcandles incident to a surface is equal to the number of lumens divided by the area, and 1 candlepower gives off 12.57 lumens.

Example—An example of how Fig. 1 and Table 1 might serve the air conditioning engineer in preliminary estimates is as follows:

Assume the dining area of a restaurant is to be air conditioned and the engineer has access to only a general floor plan. Table 1 shows that, for this application, about 10 footcandles of indirect or semi-indirect (Class C) lighting are to be expected.

TABLE 1—APPROXIMATE HEAT GAIN FROM LIGHTS

Application	Level of Illumination, Footcandles	FLUORESCENT				INCANDESCENT			
		Class[1]	Low	Avg.	High	Class[1]	Low	Avg.	High
			Btu per (sq ft) (hr)				Btu per (sq ft) (hr)		
Armories	30	A	5.25	6.0	9.0	A	12.0	14.0	19.0
Banks	30	A	5.0	7.0	10.0	A	10.0	15.0	20.0
Barber Shops and Beauty Parlors	50	B	12.0	16.5	24.5	B	20.0	24.0	30.0
Court Rooms	20	B	4.8	6.6	9.8	B	10.0	14.0	22.0
Dance Halls	5	C	1.7	3.7	8.0	B	3.5	7.0	12.0
Drafting Rooms—									
Prolonged Close Work, Art Drafting and Designing in Detail	50	B	10.0	15.0	20.0	C	25.0	40.0	50.0
Hospitals—									
General	50	A	8.0	12.0	18.0	A	25.0	35.0	55.0
Operating Rooms—									
For Major Operations	1000	A	50.0	100.0	150.0	A	100.0	200.0	300.0
For Minor Operations	200	A	20.0	40.0	60.0	A	40.0	80.0	150.0
Hotels—									
Dining Room	5	C	1.7	2.5	4.0	C	3.5	5.0	8.0
Kitchen	20	A	4.0	6.0	8.0	B	15.0	21.0	33.0
Library—									
Reading Room	30	C	9.0	15.0	25.0	C	15.0	35.0	50.0
Office Buildings—									
Bookkeeping, Typing, and Accounting	50	C	12.0	17.0	24.0	C	25.0	35.0	50.0
Post Office—									
Lobby	20	B	4.8	6.6	9.8	B	10.0	14.0	22.0
Sorting, Mailing, and File Room	30	B	7.2	10.0	15.0	B	15.0	21.0	33.0
Professional Offices—									
Waiting Rooms and Consultation Rooms	30	B	6.8	11.0	18.0	B	14.0	20.0	35.0
Restaurants, Lunch Rooms, Cafeterias—									
Dining Areas	10	C	3.4	6.0	10.0	C	7.0	10.0	20.0
Schools—									
Auditoriums	10	C	3.5	5.0	7.0	C	7.0	13.0	20.0
Class and Study Rooms	30	C	9.00	12.0	18.0	C	15.0	21.0	33.0
Store Interiors	40	B	10.0	14.0	18.0	B	20.0	25.0	35.0
Theaters and Motion Picture Houses—									
Auditoriums (Darkened)	0.1	B	.5	.8	1.0	B	1.0	1.4	1.8
Industrial Interiors[2]	30	A	5.0	7.0	9.0	A	12.0	15.0	20.0

[1]A—direct lighting system; B—semi-direct or general-diffuse lighting system; C—indirect or semi-indirect lighting system.

The type system has been indicated to allow the heating and ventilating engineer to make an adjustment if he is aware that a different type lighting system is being installed.

[2]General illumination only with industrial RLM lighting fixtures.

NOTE: Fixtures for "low," "average," and "high" values are based on rooms having approximately the following ratios of room width to ceiling height and for recommended footcandle levels for each area: Low—6.0; Average—2.5; High—1.0.

Aside from room shape, room surface reflection factors and the type fixture will cause considerable variation. While an attempt was made to base the values on typical fixtures and room reflectances, it is to be expected that wide variations in Btu's per square foot per hour will occur.